PATENT ABSTRACTS OF JAPAN

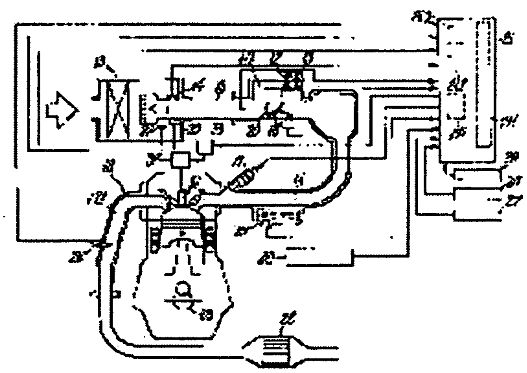
(11)Publication number : 09-032710
(43)Date of publication of application : 04.02.1997

(51)Int.Cl. F02P 5/15
F02D 45/00

(21)Application number : 07-185550
(22)Date of filing : 21.07.1995
(71)Applicant : MITSUBISHI MOTORS CORP
(72)Inventor : SAITO SAKAE

(54) IGNITION TIMING CONTROL METHOD AND DEVICE THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To eliminate the car body vibration caused by the output change between respective cylinders by finding out the change value of the rotary angle acceleration of an internal combustion engine at every cylinder and correcting the ignition timing of a cylinder for showing a combustion state with a different output for the ignition timing of the other cylinder.
SOLUTION: An ignition plug 31 is equipped at every cylinder in an engine 10 and the ignition plugs 31 of respective cylinders are connected to an ignition coil 32 as an ignition drive means, a power transistor 33 and ECU 21. The essential part of ECU 21 which is an engine control unit is formed by a micro- computer and ECU is provided with a drive circuit 171, input/output circuit 211, a memory circuit 212 stored a control program and a control circuit 213 for drive-controlling a fuel injection valve 17 and ignition plug 31 along the control program and the fuel supply control to the engine 10, a throttle valve drive control as well as an ignition timing control are carried out.



LEGAL STATUS
[Date of request for examination] 24.09.1998
[Date of sending the examiner's decision of rejection] 02.04.2002
[Kind of final disposal of application other

than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The ignition-timing control approach characterized by to amend the ignition timing of the gas column which shows the combustion condition that outputs differ so that the output of other gas columns may approach in the output of the gas column which shows the combustion condition that compare both, judge the combustion condition relevant to the output of each gas column, and outputs differ, after calculate the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizing either this variation or a decision value according to an internal combustion engine's operational status to the ignition timing of other gas columns.
[Claim 2] The ignition-timing control approach characterized by to amend the ignition timing of the gas column which compares both, judges the combustion condition relevant to the output of each gas column, and shows the big combustion condition of an output to a lag side from the ignition timing of the gas column of others which show the small combustion condition of an output after calculate the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizing either this variation or a decision value according to an internal combustion engine's operational status.
[Claim 3] The ignition-timing control approach characterized by to amend the ignition timing of the gas column which compares both, judges the combustion condition relevant to the output of each gas column, and shows the small combustion condition of an output to a tooth-lead-angle side from the ignition timing of the gas column of others which show the big combustion condition of an output after calculate the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizing either this variation or a decision value according to an internal combustion engine's operational status.
[Claim 4] In the ignition timing control approach according to claim 1 to 3, the variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration is characterized by searching for an internal combustion engine's operational status at the time of idle operation.
[Claim 5] In the ignition timing control approach according to claim 1 to 3, the variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration is characterized by asking using angular velocity at the moment of the ability setting to the instantaneous rotation angular velocity and the bottom dead point in a top dead center.
[Claim 6] In the ignition timing control approach according to claim 5, the variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration is characterized by asking for angle-of-rotation acceleration from the instantaneous rotation angular velocity in a top dead center, and the instantaneous rotation angular velocity in a bottom dead point, and calculating the variation of angle-of-rotation acceleration from the deflection of this angle-of-rotation acceleration and its average.
[Claim 7] In the ignition timing control approach according to claim 6, this average of the above-mentioned angle-of-rotation acceleration is characterized by asking by weighting of the angular rate of rotation called for this time and the average to last time.
[Claim 8] In the ignition timing control approach according to claim 1 to 3, the normalization of either the variation of the above-mentioned angle-of-rotation acceleration or a decision value is characterized by carrying out by amending according to an internal combustion engine's engine speed and inhalation-of-air information.

[Claim 9] In the ignition timing control approach according to claim 8, it is characterized by the above-mentioned inhalation-of-air information being volumetric efficiency.
[Claim 10] In the ignition timing control approach according to claim 1 to 3, after carrying out the above-mentioned normalization, an angle-of-rotation acceleration variation is compared with a decision value, and it asks for the count to which an angle-of-rotation acceleration variation exceeds a decision value, and it is characterized by amending ignition timing to a tooth-lead-angle side, so that the count is large.
[Claim 11] In the ignition timing control approach according to claim 10, it is characterized by performing the tooth lead angle of ignition timing, maintenance, and the change of a lag according to the count of the above.
[Claim 12] In the ignition timing control approach according to claim 11, when the count of the above is more than the 1st count of a judgment, the tooth lead angle of the ignition timing is carried out, when the count of the above is smaller than the 2nd count of a judgment smaller than the count of a judgment of the above 1st, the lag of the ignition timing is carried out, and the count of the above is characterized by holding ignition timing at the time more than the count of a judgment of the above 2nd smaller than the above-mentioned count of the 1st judgment.
[Claim 13] the ignition timing control approach according to claim 1 to 3 -- setting -- either of the variation of the above-mentioned angle-of-rotation acceleration, and a decision value -- it is characterized by changing another side according to engine operational status.
[Claim 14] the ignition timing control approach according to claim 13 -- setting -- either of the variation of the above-mentioned angle-of-rotation acceleration, and a decision value -- it is characterized by changing another side according to an engine speed and inhalation-of-air information.
[Claim 15] In the ignition timing control approach according to claim 14, it is characterized by the above-mentioned inhalation-of-air information being volumetric efficiency.
[Claim 16] A fluctuation detection means to detect the variation of an internal combustion engine's angle-of-rotation acceleration, and a normalizing-value detection means to normalize either the variation detected with the above-mentioned fluctuation detection means, or a decision value according to the above-mentioned internal combustion engine's operational status, and to calculate a normalization variation or a normalization decision value, A combustion aggravation decision value calculation means to compare the above-mentioned normalization variation or a normalization decision value, the above-mentioned variation, or a decision value, and to calculate a combustion aggravation decision value, The above-mentioned combustion aggravation decision value is referred to. The electronic spark timing controller characterized by having an ignition control means to control an ignition drive circuit that the ignition timing of the gas column which shows the combustion condition that outputs differ so that the output of other gas columns may be approached in the output of the combustion condition **** gas column from which an output differs should be amended to the ignition timing of other gas columns.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the ignition timing control approach of the engine of the Taki cylinder and its equipment, the ignition timing control approach that regulated the variation in combustion between each gas column especially, and its equipment.
[0002]
[Description of the Prior Art] Perform ignition processing of each gas column by proper firing order, each gas column is made to generate an output torque one by one, and engine rotation is made to continue by the ignition system of the engine of the Taki cylinder. The ignition system of this engine carries out sequential calculation according to an engine operation condition by making the predetermined crank angle in front of the compression top dead center of each gas column into ignition timing, drives a firing circuit at a tie fire stage, and is lighting each gas column. In fundamental control of this ignition timing, according to a service condition, for example, an engine speed, an inhalation air content, etc., a reference point fire stage is set up at the time of steady operation of an engine, this is suitably amended in the range which knocking does not generate, it asks for target ignition timing, and ignition processing is performed at the tie fire stage.
[0003] Decreasing by what the output which each gas column generates increases by what ignition timing of criteria is advanced for (advance), and is done for a lag by control of such ignition timing (retard) is known.
[0004]
[Problem(s) to be Solved by the Invention] By the way, with the engine of the Taki cylinder, components variation, bending of the belt train of a valve gear system, etc. result, valve timing shifts, and there is a problem of changing the air-fuel ratio for every gas column. For example, in the DOHC-type engine shown in drawing 16 , while arranging a gas column on the 1st bank and the 2nd bank, by the timing belt which makes the direction which **** a hand of cut, the exhaust cam shaft by the side of the 1st bank, an air inlet cam shaft, and an idler rotate in this order, and, subsequently air inlet cam shaft [by the side of the 2nd bank] and exhaust cam shaft side and crankshaft side body of revolution rotates in this order.
[0005] With a such DOHC-type engine, output fluctuation as shown in drawing 17 and drawing 18 arises. That is, in the V-type engine of this DOHC type, although the coincidence drive of the pumping cam shaft of a right-and-left bank is carried out by the timing belt at the time of that drive, with the clausilium energization force of each valve spring, and the cam configuration of an overlap location, the force to the direction which delays the direction or rotation which advances rotation to a pumping cam shaft arises, and this produces the variation rate of the flexible direction to a timing belt. Consequently, especially, the inclination of the bending t0 of the timing belt in the 1st bank appears greatly, and the amount of overlap becomes smaller than the value of normal. Thus, on the 1st bank where the amount of overlap became small, there is a problem of the blow by falling it being a low-speed rotation region like [at the time of an idle], an output improving, and volumetric efficiency falling conversely it being a high-speed rotation region, and causing loss of power. In addition, the output (indicated mean effective pressure Pi) of a specific gas column (here ** 5 cylinders) is comparatively large by components variation in the predetermined operation region.
[0006] Thus, by gap of the air-fuel ratio between each gas column etc., the output at the time of the

combustion for every gas column carries out increase and decrease of fluctuation delicately, this results, vibration is excited into a car body, and there is a problem of giving crew displeasure. The purpose of this invention regulates fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system, and is to offer the ignition timing control approach which can eliminate the car-body vibration resulting from the output fluctuation between each of this gas column, and its equipment.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention of claim 1 After calculating the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizing either this variation or a decision value according to an internal combustion engine's operational status, The ignition timing control approach characterized by amending the ignition timing of the gas column which shows the combustion condition that outputs differ so that the output of other gas columns may be approached in the output of the gas column which shows the combustion condition that compare both, judge the combustion condition relevant to the output of each gas column, and outputs differ to the ignition timing of other gas columns.

[0008] After invention of claim 2 calculates the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizes either this variation or a decision value according to an internal combustion engine's operational status, it compares both, judges the combustion condition relevant to the output of each gas column, and is characterized by to amend the ignition timing of the big combustion condition **** gas column of an output to a lag side from the ignition timing of other gas columns of small combustion condition ****** of an output.

[0009] After invention of claim 3 calculates the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizes either this variation or a decision value according to an internal combustion engine's operational status, it compares both, judges the combustion condition relevant to the output of each gas column, and is characterized by to amend the ignition timing of the gas column which shows the small combustion condition of an output to a tooth-lead-angle side from the ignition timing of the gas column of others which show the big combustion condition of an output.

[0010] In the ignition timing control approach according to claim 1 to 3, as for invention of claim 4, the variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration is characterized by asking at the time of idle operation by an internal combustion engine's operational status.

[0011] Invention of claim 5 is characterized by calculating the variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration using the instantaneous rotation angular velocity in a top dead center, and the instantaneous rotation angular velocity in a bottom dead point in the ignition timing control approach according to claim 1 to 3.

[0012] Invention of claim 6 is characterized by for the variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration asking for angle-of-rotation acceleration from the instantaneous rotation angular velocity in a top dead center, and the instantaneous rotation angular velocity in a bottom dead point, and calculating the variation of angle-of-rotation acceleration from the deflection of this angle-of-rotation acceleration and its average in the ignition timing control approach according to claim 5.

[0013] Invention of claim 7 is characterized by calculating this average of the above-mentioned angle-of-rotation acceleration by weighting of the angle-of-rotation acceleration called for this time and the average to last time in the ignition timing control approach according to claim 6.

[0014] It is characterized by the normalization of either the variation of the above-mentioned angle-of-rotation acceleration or a decision value performing invention of claim 8 in the ignition timing control approach according to claim 1 to 3 by amending according to an internal combustion engine's engine speed and inhalation-of-air information.

[0015] Invention of claim 9 is characterized by the above-mentioned inhalation-of-air information being volumetric efficiency in the ignition timing control approach according to claim 8.

[0016] In the ignition timing control approach according to claim 1 to 3, after it carries out the above-mentioned normalization, invention of claim 10 compares an angle-of-rotation acceleration variation with a decision value, asks for the count to which an angle-of-rotation acceleration

variation exceeds a decision value, and it is characterized by amending ignition timing to a tooth-lead-angle side, so that the count is large.
[0017] It is characterized by invention of claim 11 performing the tooth lead angle of ignition timing, maintenance, and the change of a lag in the ignition timing control approach according to claim 10 according to the count of the above.
[0018] Invention of claim 12 is set to the ignition timing control approach according to claim 11. When the count of the above is more than the 1st count of a judgment, carry out the tooth lead angle of the ignition timing, and when the count of the above is smaller than the 2nd count of a judgment smaller than the count of a judgment of the above 1st, the lag of the ignition timing is carried out. The count of the above is characterized by holding ignition timing at the time more than the count of a judgment of the above 2nd smaller than the above-mentioned count of the 1st judgment.
[0019] invention of claim 13 -- the ignition timing control approach according to claim 1 to 3 -- setting -- either of the variation of the above-mentioned angle-of-rotation acceleration, and a decision value -- it is characterized by changing another side according to engine operational status.
[0020] invention of claim 14 -- the ignition timing control approach according to claim 13 -- setting -- either of the variation of the above-mentioned angle-of-rotation acceleration, and a decision value -- it is characterized by changing another side according to an engine speed and inhalation-of-air information.
[0021] Invention of claim 15 is characterized by the above-mentioned inhalation-of-air information being volumetric efficiency in the ignition timing control approach according to claim 14.
[0022] A fluctuation detection means by which invention of claim 16 detects the variation of an internal combustion engine's angle-of-rotation acceleration, A normalizing-value detection means to normalize either the variation detected with the above-mentioned fluctuation detection means, or a decision value according to the above-mentioned internal combustion engine's operational status, and to calculate a normalization variation or a normalization decision value, A combustion aggravation decision value calculation means to compare the above-mentioned normalization variation or a normalization decision value, the above-mentioned variation, or a decision value, and to calculate a combustion aggravation decision value, It is characterized by having an ignition control means to control an ignition drive circuit that the ignition timing of the gas column which shows the combustion condition that outputs differ so that the output of other gas columns may be approached with reference to the above-mentioned combustion aggravation decision value in the output of the combustion condition **** gas column from which an output differs should be amended to the ignition timing of other gas columns.
[0023]
[Example] It is hereafter attached to the ignition timing control approach and its equipment as one example of this invention, and explains. A 6-cylinder DOHC-type internal combustion engine (it is only described as an engine 10 below) is equipped with this electronic spark timing controller. The inhalation-of-air way 11 and the exhaust air way 12 are connected to this engine 10. This inhalation-of-air way 11 inhaled the air from an air cleaner 13, detected that air content with the intake air flow sensor 14, and has led it to the engine combustion chamber through the inlet pipe 15. In addition, there is a surge tank 16 in the middle of the inhalation-of-air way 11, and fuel supply is made by the downstream from the fuel injection valve 17 supported by the engine 10.
[0024] The inhalation-of-air way 11 is opened and closed by the throttle valve 18, bypass path 11A which bypasses this throttle valve 18 is prepared further, and the ******** stepper motor valve (STM valve) 12 which functions as an ISC valve is infixed in this bypass way 11A. In addition, the first idle inflation valve 13 of the wax type with which opening is adjusted according to engine-coolant water temperature is also formed in this bypass path 11A, and it is annexed to the STM valve 12. By controlling by the engine control unit (it only being henceforth described as ECU) 21 which mentions the opening of the STM valve 12 later, with regards to actuation of the accelerator pedal by the operator, there is nothing and inhalation of air can be supplied to an engine 10 through bypass path 11A.
[0025] The throttle sensor 20 which outputs the opening stheta information on this bulb is attached to this throttle valve 18, and the electrical-potential-difference value of this sensor is inputted through the A/D converter which is not illustrated in the I/O circuit 212 of ECU21. Here, the sign 22 shows

the coolant temperature sensor with which a sign 25 outputs the water temperature signal wt of an engine 10 for the large atmospheric temperature sensor by which a sign 23 outputs the large atmospheric temperature Ta for the atmospheric pressure sensor which outputs atmospheric pressure Pa. The engine exhaust air way 12 is equipped with the linear A/F sensor 26 which outputs a real air-fuel ratio (A/F), further, a three way component catalyst 28 is arranged in the lower stream of a river of the linear A/F sensor 26, and the muffler which is not illustrated is arranged in the lower stream of a river.

[0026] If exhaust gas is in the window region based on SUTOIKIO when a three way component catalyst 28 reaches catalytic activity temperature, it can perform oxidation reduction processing of HC, CO, and NOX, and can exhaust the defanged exhaust gas. In addition, the Lean NOX catalyst which can return NOX under hyperoxia may be added by the case. furthermore, an engine 10 equips with an ignition plug 31 for every gas column -- having -- each -- the plug 31 of gas column **1-**6 is connected to the ignition coil 32, the power transistor 33, the drive circuit 34, and ECU21 as an ignition driving means. The ignition drive circuit 34 is equipped with the ignition mechanical component 341 (not similarly shown [342-346] for a configuration) shown in drawing 3 and drawing 4 for every gas column.

[0027] The ignition mechanical component 341 here is driven with a crank angle signal (deltatheta detected based on the crank angle sensor signal s1), and a reference signal (psio detected based on the TDC sensor signal s2). Here, the trigger of the single-shot trigger circuit B is carried out by reference signal psio in front of a top dead center (for example, 75 degrees) at the time of steady operation as which target ignition timing psit was determined, and after counting only the number (delay time t1 equivalent to ignition timing psi o-psi t) which was able to determine crank angle signal deltatheta, it is constituted so that an energization start signal may be outputted (refer to drawing 5). In this case, target ignition timing psit is called for as sign thetaadv at step s18 of the flow chart of drawing 15 mentioned later.

[0028] The trigger of the single-shot trigger circuit A is carried out by the energization start signal, and it is constituted so that only the number which was able to determine the crank angle signal equivalent to dwell-angle thetad may be counted and an ignition signal may be outputted. Flip-flop F-F is set by the energization start signal from single-shot trigger circuit B, and is reset by the ignition signal from single-shot trigger circuit A. Furthermore, the drive circuit PC makes a power transistor 33 turn on with the output signal in the set condition of a flip-flop, and makes the current to an ignition coil 32 pass. an ignition coil 32 produces high tension current in secondary, when a power transistor 33 turns off -- making -- this current -- the 1st -- it is told to the ignition plug 31 of cylinder **1, and ignition is performed.

[0029] the same -- the 2- the 6th -- the secondary high tension current of the ignition coil 32 of the gas column which the ignition mechanical components 342-346 of cylinder **2-**6 are also constituted, and counters target ignition timing psit -- each -- the ignition plug 31 of gas column **2 and **3 is supplied, and ignition in each gas column is performed. in addition, drawing 6 -- all -- an example of the reference point fire stage of gas column **1-**6 was shown. Here, the ignition timing of each gas column maintains spacing of 120 degrees of crank angles mostly, and is performed by turns for every gas column. As shown in the crankshaft 35 of the engine 10 here at drawing 13 , it is equipped with the crank angle sensor 24 which outputs the crank angle sensor signal s1 (it uses for calculation of crank angle signal deltatheta and an engine speed Ne), and the TDC sensor 27 which outputs the TDC sensor signal s2 (it uses for calculation of a reference signal psi), and an engine 10 is further equipped with the knock sensor 29 which outputs the knock signal Ks, and the battery voltage sensor 30 is also equipped.

[0030] In addition, the output signal from the intake air flow sensor 14 and the throttle sensor 20 which are these sensors, the atmospheric pressure sensor 22, the large atmospheric temperature sensor 23, the crank angle sensor 24, a coolant temperature sensor 25, the linear A/F sensor 26, the TDC sensor 27, a knock sensor 29, and battery voltage sensor 30 grade is inputted into the I/O circuit 211 of ECU21. As for ECU21 which is an engine control unit, the important section is formed with a microcomputer. The above-mentioned drive circuit 171, The store circuit 212 by which storing processing was carried out in the I/O circuit 211, drawing 14 thru/or the control program and each set point of drawing 15 , and drawing 8 and each calculation map of drawing 11 , the other set

points, etc., It has the control circuit 213 which carries out drive control of a fuel injection valve 17 and the ignition plug 31 along with a control program, and while performing well-known control processings, such as fuel supply control to an engine 10, and throttle-valve drive control, ignition timing control is performed.
[0031] In addition, in fuel supply control here, the basic fuel pulse width Tf based on an inhalation air content is computed, and this is multiplied by the correction factor of an air-fuel ratio and others, it decides on injector drive time amount, and injector drive control processing of common knowledge of making the injector of each gas column drive is performed. Here, if its attention is now paid to ignition-timing control, this ECU21 will have the function of the fluctuation detection means A1, the normalization variation detection means A2, combustion aggravation decision value calculation means A3, combustion state-control means A4, combustion fluctuation element A5, the angular-acceleration detection means A6, the smoothing means A7, the renewal means A8 of a threshold, and reference-value setting means A9 in ECU21 for this ignition-timing control, as shown in drawing 2 .
[0032] Here, combustion fluctuation element A5 adjusts ignition timing to the condition of a request of thetaadv with the control signal from combustion state control means A4, operation with the output which should be realized is performed, and an ignition plug 31 functions as combustion fluctuation element A5. In addition, ignition timing (control point fire stage) thetaadv is expressed with a degree type.
thetaadv=thetaB+thetaC+thetaI (j) thetaB in this formula is a fundamental-points fire stage, is the value decided by volumetric efficiency Ev and the engine speed Ne, and is calculated on a predetermined map. Volumetric efficiency Ev calculates inhalation air content A/N per engine 1 rotation from the inhalation air content A from an intake air flow sensor 14, and engine-speed N from the crank angle sensor 24, and volumetric efficiency Ev is computed based on this information.
[0033] thetaC is the various ignition timing correction value according to wt, an intake-air temperature Ta, atmospheric pressure Pa, etc. whenever [engine-coolant water temperature]. thetaI (j) is the combustion fluctuation correction value for performing ignition timing control corresponding to combustion fluctuation like the after-mentioned. By the way, the electronic spark timing controller of this example is equipped with an angular-acceleration detection means A6 to detect the angular acceleration of the crankshaft 35 driven in an engine, and the angular-acceleration detection means A6 is constituted as follows.
[0034] That is, as shown in drawing 13 , the angular-acceleration detection means A6 is equipped with the crank angle sensor 24, the TDC sensor 27, and ECU21 as a main element, and the crank angle sensor 24 offers a crankshaft 35 and the rotation member 36 rotated in one. The rotation member 36 is constituted so that the pulse output to which the detecting element 241 equipped so that the 1-3rd vanes 36A-36C which project in radial might be formed around it and it might counter from both sides to these 1-3rd vanes detects passage of the 1-3rd vanes of ****** to rotation of the rotation member 36 optically or in electromagnetism, and corresponds to it may be performed. Each is equipped with the hoop direction die length corresponding to crankshaft angle of rotation of a fixed include angle, and the 1-3rd vanes 36A-36C are isolated and arranged in the hoop direction for every predetermined include-angle spacing.
[0035] That is, the opposite edge of a ****** vane is mutually arranged with include-angle spacing of 120 degrees. By the way, the TDC sensor 27 has fixed to the cam shaft which is not illustrated, and while a crankshaft 35 rotates two times and a cam shaft rotates one time, whenever a cam shaft takes the specific rotation location which counters one mind etc., it changes so that a pulse output may be generated. And this equipment carried in the six cylinder engine by which ignition actuation is performed to a gas column numerical order For example, when the edge (front end or back end) of 3rd vane 36C passes a detecting element 241, while a crankshaft rushes into the 1st crankshaft angle-of-rotation field corresponding to either [which makes the 1st cylinder group] the 1st cylinder and the 4th cylinder When the edge of 1st vane 36A passes a detecting element 241, a crankshaft secedes from the 1st angle-of-rotation field.
[0036] Similarly it rushes into the 2nd crankshaft angle-of-rotation field corresponding to either [which makes the 2nd cylinder group at the time of passage of the edge of 1st vane 36A] the 2nd cylinder and the 5th cylinder. Subsequently It rushes into the 3rd clan angle-of-rotation field

corresponding to either [which makes the 3rd cylinder group at the time of passage of the edge of 2nd vane 36B] the 3rd cylinder and the 6th cylinder, and, subsequently to the time of passage of the edge of 3rd vane 36C, balking from this field is performed. And discernment from the 1st cylinder and the 4th cylinder, discernment from the 2nd cylinder and the 5th cylinder, and discernment from the 3rd cylinder and the 6th cylinder are performed based on the output of the TCD sensor 27. such a configuration -- detection of angular acceleration -- the next ** -- it is carried out like.
[0037] That is, among an engine speed, the pulse output from the crank angle sensor 24 and the detecting signal of the TDC sensor 27 are serially inputted into ECU21, and it repeats an operation periodically and performs it. Moreover, it distinguishes the thing of what position of those in which the pulse output from the crank angle sensor 24 carried out the sequential input after the input time of the pulse output from the TDC sensor 27 ECU21 is. It identifies by this whether the pulse output from the inputted crank angle sensor 24 is a thing corresponding to the gas column of what position, and the gas column under activation is mainly preferably identified [(output line] for an expansion line as a discernment gas column at present in;BTDC75").
[0038] And ECU21 will start the timer for periodic measurement (not shown), if inrush to the crankshaft angle-of-rotation field corresponding to the discernment gas column group m (m is 1, 2, or 3) is distinguished according to the pulse signal from the crank angle sensor 24. subsequently, balking from the crankshaft angle-of-rotation field corresponding to the discernment gas column group m in ECU21 when the next pulse output is inputted from the crank angle sensor 24 -- distinguishing -- the time check of the timer for periodic measurement -- actuation is suspended -- making -- a time check -- a result is read. this time check -- the result expresses the period TN (n) which becomes settled with two predetermined crankshafts corresponding to the time interval TN (n), i.e., the discernment gas column group, of the balking time from [from an inrush-to crankshaft angle-of-rotation field corresponding to discernment gas column group m point in time] the field concerned.
[0039] It means that the subscript n in a period TN (n) corresponds to the n-th ignition actuation [in / in the period concerned / a discernment gas column] (this time) here. Moreover, in a six cylinder engine, a period TN (n) turns into a discernment gas column group's period between 120-degree crank angles (time interval between operational status BTDC75" in a ****** gas column), and, more generally turns into a period between crank angles whenever [in N cylinder engine] (720 degrees/N). In addition, the above-mentioned pulse output showing balking from the crankshaft angle-of-rotation field corresponding to this discernment gas column also expresses inrush to the crankshaft angle-of-rotation field corresponding to the following discernment gas column. Therefore, while the gas column discernment step about the following discernment gas column is performed according to this pulse output, the timer for the account measurement of a neck is restarted that the periodic measurement concerning the following discernment gas column concerned should be started.
[0040] By such actuation, although ECU21 ** the period TN between 120-degree cranks (n), when a series of conditions of resulting [from ** 1 cylinder] in ** 6-cylinder are displayed, it comes to be shown in drawing 7 , and the period between 120-degree cranks is expressed with TN (n-5) to TN (n). Angular-acceleration ACC(n) of the crankshaft in the period concerned is computed by the degree type using these detection values.
ACC(n) =1/TN (n) - {KL(m)/TN(n)-KL(m-1)/TN (n-1)}
Here, KL (m) is segment correction value, and the segment correction value KL (m) is computed by ECU21 by the degree type in order to perform amendment for removing the period-measurement error by the variation in vane include-angle spacing on vane manufacture and anchoring in relation to this discernment gas column.
[0041] KL (m) = {KL(m-3) x(1-XMFDKFG)+KR(n) x(XMFDKFD)}
However, XMFDKFG shows segment amendment gain. Moreover, it is set up for every gas column group corresponding to m in KL (m), and m= 3 corresponds to m= 2, gas column group **3, and **6 to m= 1, gas column group **2, and **5 to gas column group **1 and **4, respectively, and as shown in drawing 7 , KL(1) -KL(3) is repeated. And since m-1 in KL (m-1) means the thing in front of corresponding m, KL(m) = -- the time of KL (1) -- KL(m-1) =KL (3) and KL (m) = -- the time of KL (2) -- KL(m-1) =KL (1) and KL (m) = -- time KL(m-1) = [KL / (3)] -- KL (2) is shown.

[0042] Furthermore, KL (m-3) in an upper type shows KL (m) of the time of before in the same gas column group, ** [in / in KL at the time of the operation of ** 4-cylinder (m-3) / front ** 1 cylinder] KL (1) is used, and KL [in / in KL at the time of the operation of ** 1 cylinder (m-3) / front ** 4-cylinder] (1) is used. KL [in / in KL at the time of a **5 cylinder operation (m-3) / front ** 2 cylinder] (2) is used, and ** [in / in KL at the time of the operation of ** 2 cylinder (m-3) / front **5 cylinder] KL (2) is used. KL [in / in KL at the time of a ** 6-cylinder operation (m-3) / front ** 3 cylinder] (3) is used, and KL [in / in KL at the time of the operation of ** 3 cylinder (m-3) / front ** 6-cylinder] (3) is used. On the other hand, KR (n) in an upper type is calculated by the degree type.

[0043] KR(n) =3 and TN(n)+TN(n-1)+TN (n-2)

This is a measurement value corresponding to the average measurement time amount to this measurement time amount TN (n) from the measurement time amount TN (n-2) of 2 times ago, and filtering is performed to KR (n) on the occasion of calculation of the segment correction value KL (m) temporarily using the above-mentioned formula by the segment correction value gain XMFDKFG. By the way, the electronic spark timing controller of this example is equipped with a fluctuation detection means A1 to detect the variation of angular acceleration using the detecting signal of the angular-acceleration detection means A6.

[0044] And the operation of the fluctuation detection means A1 is constituted so that it may be carried out by searching for the difference of the smooth value which graduated each detected rate with the smoothing means A7, and the angular acceleration outputted from the angular-acceleration detection means A6.

[0045] That is, acceleration variation deltaACC(n) is computed by the degree type in the fluctuation detection means A1.

deltaACC(n) =ACC(n)-ACCAV (n)

ACCAV (n) is the smooth value which graduated the detected angular velocity with the smoothing means A7, and is computed by performing filtering temporarily by the degree type here. ACCAV(n) = alpha-ACCAV (n-1) - (1-alpha) and ACC -- (n) -- alpha is the updating gain in primary filter processing here, and about 0.95 value is taken.

[0046] Moreover, variation deltaACC(n) outputted from the fluctuation detection means A1 is normalized according to engine operational status, and a normalization variation detection means A2 to calculate the normalization variation IAC (n) is established. That is, calculation of the normalization variation IAC in the normalization variation detection means A2 (n) is performed by the degree type.

IAC(n) =deltaACC(n), Kte (Ev, Ne)

Here, Kte (Ev, Ne) is an output correction factor, and is set up with the property shown in drawing 11 .

[0047] The property of drawing 11 takes volumetric efficiency Ev, takes the output correction factor Kte (Ev, Ne) to this volumetric efficiency Ev on an axis of ordinate, and is shown in the axis of abscissa, and it is constituted so that an engine speed Ne becomes large, and the property of the line by the side of the upper right may be adopted. Therefore, the property of drawing 11 is memorized as a map, and the output correction factor Kte (Ev, Ne) is set up in ECU21, and it consists of the engine speeds Ne and volumetric efficiency Ev which are computed from the detecting signal of crank angle sensor 24 grade so that normalization by the amendment corresponding to engine power may be performed. And the normalization variation IAC (j) is compared with the predetermined threshold IACTH, combustion aggravation decision value calculation means A3 which calculates the combustion aggravation decision value VAC (j) is prepared, and the combustion aggravation decision value VAC (j) is constituted so that the amount of aggravation in which the normalization variation IAC (j) is less than a threshold IACTH may be accumulated and calculated.

[0048] That is, the combustion aggravation decision value VAC (j) is computed by the degree type.

VAC(j) =sigma {IAC(j) <IACTH} x {IACTH-IAC (j)}

Here, {IAC(j) <IACTH} of an upper type takes "1", when IAC(j) <IACTH is materialized, when not materialized, it is the function which takes "0", and when the normalization variation IAC (n) is less than the predetermined threshold IACTH, it is constituted so that this amount than which were less may be accumulated as an amount of aggravation. Therefore, the combustion aggravation decision

value VAC (j) accumulates the amount of aggravation which made weight the difference of a threshold IACTH and the normalization variation IAC (j), is calculated, makes effect of near a threshold small, and it is constituted so that the condition of aggravation may be reflected correctly.
[0049] And the predetermined threshold IACTH in combustion aggravation decision value calculation means A3 is updated by the renewal means A8 of a threshold location corresponding to an engine operation condition. In addition, the above-mentioned subscript j shows the gas column number. Moreover, as a combustion aggravation decision value VAC (j), you may accumulate and ask for the count to which the normalization variation IAC (j) turns around a threshold IACTH the bottom using a easier program. That is, the combustion aggravation decision value VAC (j) may be calculated by the degree type.
VAC (j) =sigma {IAC(j) <IACTH}}
The result of an operation from above combustion aggravation decision value calculation means A3 is constituted so that it may be used by combustion state control means A4.
[0050] That is, combustion state control means A4 is constituted so that the ignition plug 31 as engine combustion surge-drum element A5 may be controlled with reference to the combustion aggravation decision value VAC (j) computed by combustion aggravation decision value calculation means A3 and the combustion aggravation gas column j about origin/datum fire stage thetaB set up according to the engine operation condition from reference-value setting means A9. As a reference value about control of combustion surge-drum element A5 by combustion state control means A4, the upper limit reference value VACTH1 and the minimum reference value VACTH2 are set up by reference-value setting means A9. And the control by combustion surge-drum element A5 is constituted so that a combustion aggravation decision value may be performed in order to dedicate VAC (j) between the upper limit reference value VACTH1 and the minimum reference value VACTH2.
[0051] That is, the control by the ignition plug 31 as combustion surge-drum element A5 is constituted so that it may be performed by amendment of reference point fire stage thetaB for ignition timing control as mentioned above, and control point fire stage thetaadv is constituted so that it may be computed by the degree type.
thetaadv=thetaB+thetaC+thetaI (j) and thetaI (j) in this formula change so that it may be adjusted as follows. Amendment to which the tooth lead angle of the ignition timing is carried out is performed by the calculation of correction factor thetaI (j) by the degree type noting that it is the case where the combustion variation is getting worse more than predetermined, when the combustion aggravation decision value VAC (j) is over the upper limit reference value VACTH1 first.
[0052] thetaI(j) =thetaI (j) +Kadv- {VAC(j)-VACTH1}
This shows the correction value of a tooth-lead-angle side upper right property among the amendment properties shown in drawing 8 , and Kadv is a multiplier which shows the inclination of a property. And thetaI (j) of the right-hand side shows the correction factor computed in the front operation cycle (n-1) about the number of j cylinders, and updating is performed by the upper type. In addition, drawing 8 takes the combustion aggravation decision value VAC along an axis of abscissa, takes correction factor thetaI (j) along an axis of ordinate, and shows the amendment property. On the other hand, amendment to which the lag of the ignition timing is carried out is performed by the calculation of correction factor thetaI (j) by the degree type noting that it is possible to perform lag-ization, when the combustion aggravation decision value VAC (j) is less than the minimum reference value VACTH2.
[0053] thetaI(j) =thetaI (j) +Kret- {VAC(j)-VACTH2}
This shows the correction value of a lag side lower left property among the amendment properties shown in drawing 8 , and Kret is a multiplier which shows the inclination of a property. Furthermore, in order to maintain ignition timing at a front condition noting that it is proper operational status, when the combustion aggravation decision value VAC (j) is one or less upper limit reference value VACTH in two or more minimum reference values VACTH, it changes so that correction factor thetaI (j) may not be changed. This corresponds to the flat property between the tooth-lead-angle side upper right property shown in drawing 8 , and a lag side lower left property, and constitutes the neutral zone about amendment.
[0054] Here, focusing on the combustion fluctuation desired value VAC 0, the minimum reference

value VACTH2 is set as the value of (VAC0-deltaVAC), and the upper limit reference value VACTH1 is set as the value of (VAC0-deltaVAC) for the upper limit reference value VACTH1 and the minimum reference value VACTH2. The combustion fluctuation desired value VAC 0 is a value corresponding to the desired value (about 10%) of COV (Coefficient of variance), and a finite period (128 cycles) estimates rotation fluctuation, or he is trying to prevent the limit cycle by the error which originated in being as follows [a threshold] and calculating by being made not to carry out ignition timing amendment in the range of deltaVAC in the both sides of the combustion fluctuation desired value VAC 0.
[0055] And above-mentioned correction factor thetaI (j) is constituted so that it may clip with a bound value, for example, by being set up so that it may fall within the range of -1<thetaI(j) <+5, not performing rapid amendment, but amending gradually, it is constituted so that generating of a shock etc. may be prevented and stable positive control may be performed. Below, the ignition timing control approach using the electronic spark timing controller as one example of this invention constituted as mentioned above is explained along with the control program of ECU21.
[0056] ECU21 of an engine 10 starts actuation with ON actuation of the ignition key which is not illustrated, control by the Maine processing is started, and initial functional sets, such as a check of each function and an initial value set, are made, then the various operation information on engine is read, and control processing of drawing 14 and drawing 15 is reached on it. Here, angular-acceleration ACC(n) is detected by the angular-acceleration detection means A6 at step s1. Here, the operation used for detection is based on a degree type.
[0057] ACC(n) =1/TN (n) - {KL(m)/TN(n)-KL(m-1)/TN (n-1)}
Here, KL (m) is segment correction value, and the segment correction value KL (m) is computed by ECU21 by the degree type in order to perform amendment for removing the period-measurement error by the variation in vane include-angle spacing on vane manufacture and anchoring in relation to this discernment gas column.
[0058] KL (m) = {KL(m-3) x(1-XMFDKFG)+KR(n) x(XMFDKFD)}
However, XMFDKFG shows segment amendment gain. On the other hand, KR (n) in an upper type is calculated by the degree type.
[0059] KR(n) =3 and TN(n)+TN(n-1)+TN (n-2)
This is a measurement value corresponding to the average measurement time amount to this measurement time amount TN (n) from the measurement time amount TN (n-2) of 2 times ago, and primary filter processing by the segment correction value gain XMFDKFG is performed to KR (n) on the occasion of calculation of the segment correction value KL (m) using the above-mentioned formula. And average acceleration ACCAV (n) is computed in step s2.
[0060] Here, it is the smooth value which graduated ACCAV (angular-velocity ACC(n by which n) was detected) with the smoothing means A7, and is computed by performing primary filtering ** by the degree type.
ACCAV(n) = alpha-ACCAV (n-1) - (1-alpha) and ACC (n)
alpha is the updating gain in filtering here temporarily, and about 0.95 value is taken. Subsequently, acceleration variation deltaACC(n) is detected by the fluctuation detection means A1 in step s3.
[0061] That is, acceleration variation deltaACC(n) is computed by the degree type by searching for a difference with the equalization acceleration ACCAV as angular-velocity ACC(n) detected by the angular-acceleration detection means A6, and a smooth value graduated with the smoothing means A7 (n).
deltaACC(n) =ACC(n)-ACCAV (n)
Moreover, in step s4, the normalization variation IAC (n) which normalized variation deltaACC(n) outputted from the fluctuation detection means A1 with the normalization variation detection means A2 according to engine operational status is computed by the degree type.
[0062]
IAC(n) =deltaACC(n), Kte (Ev, Ne)
Here, Kte (Ev, Ne) is an output correction factor, and is set up with the property shown in drawing 11 . The property of drawing 11 takes volumetric efficiency Ev, takes the output correction factor Kte (Ev, Ne) to this volumetric efficiency Ev on an axis of ordinate, and is shown in the axis of abscissa, and it is constituted so that an engine speed Ne becomes large, and the property of the line

by the side of the upper right may be adopted. That is, from the engine speed Ne and volumetric efficiency Ev which are memorized as a map and computed from the detecting signal of crank angle sensor 24 grade in the property of drawing 11 , the output correction factor Kte (Ev, Ne) is set up in ECU21, and normalization by the amendment corresponding to engine power is performed.
[0063] Here, it attaches and explains to the control characteristic at the time of carrying out the above normalization corresponding to engine power. That is, angular-acceleration omega' is shown like a degree type.
omega'=1/Ie (Te-Tl) and .... ** -- here, Te:engine torque, Tl:load torque, and Ie:moment of inertia are shown.
[0064]
on the other hand -- omega'=omegao -- '+deltaomega' .... ** -- here -- omegao' -- :average angular acceleration is shown.
[0065] ** From ** type, it is omegao'+deltaomega' =1-/Ie- (Te-Tl).
= Depend 1-/Ie and (Teo-Tl) +deltaTe/Ie, and it is deltaomega'=deltaTe/Ie........ By the detection technique of acceleration ACC(n) in ** and step s1 mentioned above in time, when engine-torque information does not have load disturbance, it is saved comparatively well. And as shown in ** type, while using fluctuation deltaomegao[from average angular-acceleration omega o']' "acceleration variation deltaACC(n)", in consideration of the statistical property of combustion fluctuation, control in which combustion chamber fluctuation was made to reflect certainly is performed by controlling as a normalization output "the normalization variation IAC (n)" in consideration of moment of inertia Ie.
[0066] If actuation of step s4 is performed, subsequently, actuation of combustion aggravation decision value calculation means A3 of steps s5-s8 will be performed, the normalization variation IAC (j) will be compared with the predetermined threshold IACTH, and the aggravation decision value VAC (j) will be computed by the degree type.
[0067] VAC(j) =sigma {IAC(j) <IACTH} x {IACTH-IAC (j) }
First, in step s7, difference deltaIAC (n) of the normalization variation IAC (n) and the predetermined threshold IACTH is computed, and, subsequently it is judged in step s8 whether difference deltaIAC (n) is negative. It corresponds to the function {IAC(j) <IACTH} in an upper type, this decision takes "1", when IAC(j) <IACTH is materialized, and when not materialized, it performs actuation which takes "0."
[0068] Namely, since deltaIAC (n) is forward when IAC(j) <IACTH is materialized, through "No" root, accumulation of the combustion aggravation decision value VAC in step s8 (j) is performed, and "1" will be taken the above-mentioned function. On the other hand, since deltaIAC (n) is negative when IAC(j) <IACTH is not materialized, deltaIAC(n) =0 is performed by step s7 through the "Yes" root. By this, at step s8, change with the condition that accumulation of the combustion aggravation decision value VAC (j) is not performed, and "1" will be taken the above-mentioned function.
[0069] When the normalization variation IAC (n) as shown in point A-D by drawing 9 is less than the predetermined threshold IACTH by this, this amount than which were less will be accumulated as an amount of aggravation.
[0070] Therefore, the combustion aggravation decision value VAC (j) accumulates the amount of aggravation which made weight the difference of a threshold IACTH and the normalization variation IAC (n), and is calculated, effect of the numeric value near a threshold is made small, and the condition of aggravation is correctly reflected in the combustion aggravation decision value VAC (j). And the predetermined threshold IACTH in the combustion aggravation decision value VAC (j) is constituted so that it may be updated by the renewal means A8 of a threshold corresponding to an engine operation condition. In addition, the above-mentioned subscript j shows the gas column number, and the combustion aggravation decision value VAC (j) is accumulated by each gas column j of every.
[0071] Subsequently, step s9 is performed and it is judged whether n which shows the count of a sampling exceeded 128. That is, when it is judged whether the addition section shown in drawing 7 passed and it has not passed, "No" root is taken, step s11 is performed, and step s18 is performed, carrying out the increment of the count n in "1", and not performing fuel amendment. Thereby,

within the addition section of 128 cycle, amendment about correction factor thetaI (j) in ignition timing thetaadv is not performed, but accumulation of the combustion aggravation decision value VAC (j) is performed chiefly.

[0072] Therefore, the combustion aggravation decision value VAC (j) became the set-up count of combustion, for example, the business updated every 128 cycle, and stable positive control reflecting a statistical property is performed by performing control by grasp of the combustion condition for a comparatively long period. And progress of the addition section performs step s10 - step s16 through the root of "Yes" of step s9. First, in step s10, Count n is reset by "1" and, subsequently the comparison with the predetermined reference value set up by reference-value setting means A9 is performed with reference to the combustion aggravation decision value VAC (j) in step s12 and step s13.

[0073] First, when the comparison with the combustion aggravation decision value VAC (j) and the upper limit reference value VACTH1 is performed and the combustion aggravation decision value VAC (j) is over the upper limit reference value VACTH1 (i.e., as shown in drawing 10 , when the amount of aggravation of combustion fluctuation has crossed the limitation), in step s13, calculation of correction factor thetaI (j) by the degree type is performed.

thetaI(j) =thetaI (j) +Kadv- {VAC(j)-VACTH1}

This computes the correction value of the tooth-lead-angle side upper right property shown in drawing 8 , and amendment to which the tooth lead angle of the ignition timing is carried out is performed by calculation of thetaI (j) noting that it is the case where the combustion variation is getting worse more than predetermined. Kadv is a multiplier which shows the inclination of a property here, thetaI (j) of the right-hand side shows the correction factor computed in the front operation cycle (n-1) about the number of j cylinders, and updating is performed by the upper type.

[0074] Moreover, when the combustion aggravation decision value VAC (j) is less than the minimum reference value VACTH2, the "Yes" root is taken in step s14, and amendment to which the lag of the ignition timing is carried out is performed by calculation of correction factor thetaI (j) noting that it is possible further to perform lag-ization.

thetaI(j) =thetaI (j) +Kret- {VAC(j)-VACTH2}

This computes the correction value of the lag side lower left property shown in drawing 8 , and Kret is a multiplier which shows the inclination of a property. Furthermore, when the combustion aggravation decision value VAC (j) is one or less upper limit reference value VACTH in two or more minimum reference values VACTH, it has set to step 12 and step s13, and a gap also takes "No" root, and in order to maintain ignition timing at a front condition noting that it is proper operational status, correction factor thetaI (j) is not changed.

[0075] This corresponds to the flat property between the tooth-lead-angle side upper right property shown in drawing 8 , and a lag side lower left property, and constitutes the neutral zone about amendment. Here, focusing on the ignition timing fluctuation desired value VAC 0, the minimum reference value VACTH2 is set as the value of (VAC0-deltaVAC), and the upper limit reference value VACTH1 is set as the value of (VAC0-deltaVAC) for the upper limit reference value VACTH1 and the minimum reference value VACTH2. The combustion fluctuation desired value VAC 0 is a value corresponding to the desired value (about 10%) of COV (Coefficient of variance), and a finite period (128 cycles) estimates rotation fluctuation, or he is trying to prevent the limit cycle by the error which originated in being as follows [a threshold] and calculating by being made not to carry out ignition timing amendment in the range of deltaVAC in the both sides of the combustion fluctuation desired value VAC 0.

[0076] And step s16 is performed and the combustion aggravation decision value VAC (j) is reset by "0." Furthermore, in step s17, when correction factor thetaI (j) exceeds a bound value, it clips in the threshold value of the exceeded side. For example, when it is set up so that it may fall within the range of -1<thetaI(j) <+5, if the calculation value in step s13 exceeds +5, it will be set as +5, and if the calculation value in step s14 is less than -1, it will be set as -1. By this not performing rapid amendment but amending gradually, generating of a shock etc. is prevented and stable positive control is performed.

[0077] And in step s18, amendment of fundamental-points fire stage thetaB for the ignition processing by correction factor thetaI (j) determined as mentioned above is performed. That is,

control point fire stage thetaadv is computed by the degree type.
thetaadv=thetaB+thetaC+thetaI (j) Ignition control of the ignition plug 31 which is a combustion surge-drum element by combustion state control means A4 is performed by amendment of this fundamental-points fire stage thetaB. this ignition control -- each gas column -- (-- as every j) performs and it is shown in drawing 12 , lag processing or tooth-lead-angle processing is performed for every gas column, and the output level of all gas columns is arranged with this level. For this reason, an engine 10 is maintained at the stable operational status, and excitation of the vibration to the car-body side by the variation in the output between each gas column is prevented.
[0078]
[Effect of the Invention] As for invention of claim 1, the variation of an internal combustion engine's angle-of-rotation acceleration is calculated for every gas column. Either this variation or a decision value is normalized according to an internal combustion engine's operational status. So that both may be compared, the combustion condition relevant to the output of each gas column may be judged and the output of the gas column which shows the combustion condition that outputs differ may approach the output of other gas columns Since the ignition timing of the gas column which shows the combustion condition that outputs differ is amended to the ignition timing of other gas columns, the output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.
[0079] As for invention of claim 2, the variation of an internal combustion engine's angle-of-rotation acceleration is calculated for every gas column. Either this variation or a decision value is normalized according to an internal combustion engine's operational status. Since the ignition timing of the gas column which both are compared, and the combustion condition relevant to the output of each gas column is judged, and shows the big combustion condition of an output is amended at a lag side from the ignition timing of the gas column of others which show the small combustion condition of an output The output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.
[0080] As for invention of claim 3, the variation of an internal combustion engine's angle-of-rotation acceleration is calculated for every gas column. Either this variation or a decision value is normalized according to an internal combustion engine's operational status. Since it is amended at a tooth-lead-angle side from the ignition timing of the gas column of others which show the big combustion condition of an output, the ignition timing of the gas column which both are compared, and the combustion condition relevant to the output of each gas column is judged, and shows the small combustion condition of an output The output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.
[0081] As for invention of claim 4, especially in the variation of an internal combustion engine's angle-of-rotation acceleration, in the ignition timing control approach according to claim 1 to 3, the output of the gas column from which an output differs at the time of an idle since an internal combustion engine's operational status is searched for at the time of idle operation comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column at the time of an idle can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.
[0082] In the ignition timing control approach according to claim 1 to 3, since invention of claim 5 calculates especially the variation of an internal combustion engine's angle-of-rotation acceleration using the instantaneous rotation angular velocity in a top dead center, and the instantaneous rotation angular velocity in a bottom dead point, it can calculate the variation of angle-of-rotation

acceleration comparatively easily. For this reason, the variation of angle-of-rotation acceleration can be calculated certainly, and car-body vibration which originates in the output fluctuation between each gas column can be prevented more certainly.

[0083] In the ignition timing control approach according to claim 5, since especially the variation of an internal combustion engine's angle-of-rotation acceleration asks for angle-of-rotation acceleration from the instantaneous rotation angular velocity in a top dead center, and the instantaneous rotation angular velocity in a bottom dead point and invention of claim 6 calculates the variation of angle-of-rotation acceleration from the deflection of this angle-of-rotation acceleration and its average, it can calculate the variation of angle-of-rotation acceleration comparatively easily. For this reason, the variation of angle-of-rotation acceleration can be calculated certainly, and car-body vibration can be prevented more certainly.

[0084] The dependability of the average by which especially this average of angle-of-rotation acceleration was calculated by weighting of the angle-of-rotation acceleration called for this time and the average to last time, and invention of claim 7 was computed in the ignition timing control approach according to claim 6 increases. For this reason, the dependability of the variation of the computed angle-of-rotation acceleration increases, and car-body vibration can be prevented more certainly.

[0085] In the ignition timing control approach according to claim 1 to 3, especially, since invention of claims 8 and 9 amends the normalization of either the variation of angle-of-rotation acceleration, or a decision value according to an internal combustion engine's engine speed and inhalation-of-air information, for example, volumetric efficiency, it can perform this amendment with sufficient responsibility, and the output of the gas column from which an output differs comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.

[0086] Invention of claims 10 and 11 is set to the ignition timing control approach according to claim 1 to 3. After normalizing especially, an angle-of-rotation acceleration variation is compared with a decision value. Since it asks for the count to which an angle-of-rotation acceleration variation exceeds a decision value, ignition timing is amended to a tooth-lead-angle side, so that that count is large, or the tooth lead angle of ignition timing, maintenance, and the change of a lag are performed, the output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.

[0087] Invention of claim 12 is set to the ignition timing control approach according to claim 11. Especially, when a count is more than the 1st count of a judgment, carry out the tooth lead angle of the ignition timing, and when a count is smaller than the 2nd count of a judgment smaller than the 1st count of a judgment, the lag of the ignition timing is carried out. Change that a count holds ignition timing at the time more than the 2nd count of a judgment smaller than the count of the 1st judgment may be performed, and the output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.

[0088] In the ignition timing control approach according to claim 1 to 3, especially as for invention of claim 13, the output of the variation and decision value of angle-of-rotation acceleration it is [output] the gas column from which an output differs by this modification either since another side is changed according to engine operational status comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.

[0089] In the ignition timing control approach according to claim 13, especially as for invention of

claims 14 and 15, the output of the variation and decision value of angle-of-rotation acceleration it is [output] the gas column from which this amendment can be performed with sufficient responsibility, and an output differs since another side is changed according to an engine speed and inhalation-of-air information, for example, volumetric efficiency, either comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.
[0090] As for invention of claim 16, the variation of an internal combustion engine's angle-of-rotation acceleration is detected by the fluctuation detection means. Either the variation detected with the fluctuation detection means or a decision value is normalized according to an internal combustion engine's operational status by the normalizing-value detection means, and a normalization variation or a normalization decision value is calculated. A normalization variation or a normalization decision value, a variation, or a decision value is compared by the combustion aggravation decision value calculation means, and a combustion aggravation decision value is calculated. With an ignition control means Since an ignition drive circuit is controlled so that the output of the gas column which shows the combustion condition that a combustion aggravation decision value is referred to and outputs differ approaches the output of other gas columns, and the ignition timing of the gas column which shows the combustion condition that outputs differ is amended to the ignition timing of other gas columns The output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram of the engine which adopts the ignition timing control approach as one example of this invention, and equips the equipment.
[Drawing 2] It is the functional-block side with which ECU of the electronic spark timing controller of drawing 1 is equipped.
[Drawing 3] They are ECU of the electronic spark timing controller of drawing 1 , and the outline block diagram of an ignition control circuit.
[Drawing 4] It is the functional block diagram of the ignition mechanical component in the ignition control circuit which the electronic spark timing controller of drawing 1 uses.
[Drawing 5] It is the wave form chart showing actuation of the ignition mechanical component of drawing 4 .
[Drawing 6] It is the explanatory view of the firing order of the engine equipped with the electronic spark timing controller of drawing 1 .
[Drawing 7] It is a wave form chart for explaining rotation actuation of the engine equipped with the electronic spark timing controller of drawing 1 .
[Drawing 8] It is the characteristic ray Fig. of the correction factor thetaI(j) calculation map which ECU of the electronic spark timing controller of drawing 1 uses.
[Drawing 9] It is the wave form chart of the fluctuation acceleration of the engine equipped with the electronic spark timing controller of drawing 1 .
[Drawing 10] It is the characteristic ray Fig. of the aggravation addition value-combustion variation which is the difference of the normalization variation which ECU of the electronic spark timing controller of drawing 1 uses, and a threshold.
[Drawing 11] ECU of the electronic spark timing controller of drawing 1 is the characteristic ray Fig. of the output correction factor calculation map used by normalization.
[Drawing 12] It is drawing explaining amendment of the ignition timing of each gas column of the electronic spark timing controller of drawing 1 .
[Drawing 13] It is the typical perspective view showing the rotation fluctuation detecting element which the electronic spark timing controller of drawing 1 uses.
[Drawing 14] It is the upper part of the flow chart of the control program which ECU of the electronic spark timing controller of drawing 1 performs.
[<A HREF="/Tokujitu/tjitemdrw.ipdl?N0000=239&N0500=1 E_N/;?6?
<=8> ?///&N0001=741&N0552=9&N 0553= 000017" TARGET="tjitemdrw"> drawing 15 --] It is the lower part of the flow chart of the control program which ECU of the electronic spark timing controller of drawing 1 performs.
[Drawing 16] It is the explanatory view of fluctuation of the timing belt in the 1st and 2nd bank of the engine equipped with the conventional electronic spark timing controller.
[Drawing 17] It is an output-characteristics Fig. for every gas column of the engine equipped with the conventional electronic spark timing controller.
[Drawing 18] It is the property Fig. of the amount of overlap for every gas column of the engine equipped with the conventional electronic spark timing controller, and an inhalation air content.
[Description of Notations]
10 Engine

14 Intake Air Flow Sensor
20 Throttle Sensor
21 ECU
24 Crank Angle Sensor
27 TDC Sensor
29 Knock Sensor
31 Ignition Plug
341-346 Ignition mechanical component
35 Crankshaft
thetaadv Ignition timing
A6 Angular-acceleration detection means
TN (n) Period between cranks
A1 Fluctuation detection means
A2 Normalization variation detection means
A3 Combustion aggravation decision value calculation means
A4 Combustion state control means
A5 Combustion fluctuation element
A6 Angular-acceleration detection means
A7 Smoothing means
A8 Renewal means of a threshold
A9 Reference-value setting means
thetaB Fundamental-points fire stage
Ev Volumetric efficiency
Ne Engine speed
A/N Inhalation air content per engine 1 rotation
thetaI (j) Combustion fluctuation correction value
omega' Angular acceleration
omegao' Average angular acceleration
deltaomegao' Fluctuation
deltaACC (n) Acceleration variation
Ie Moment of inertia
IAC (n) Normalization variation

[Translation done.]

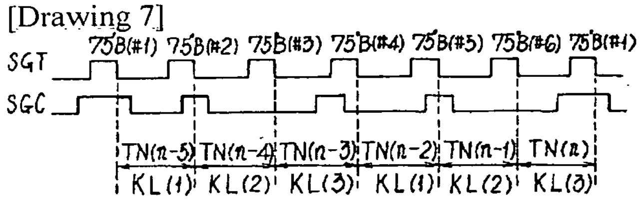
* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

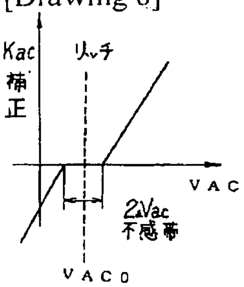
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

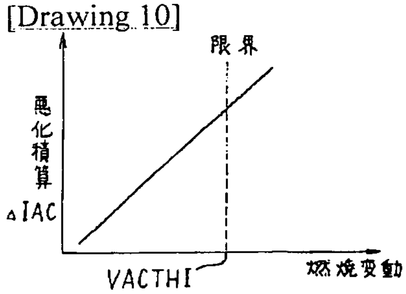
[Drawing 7]



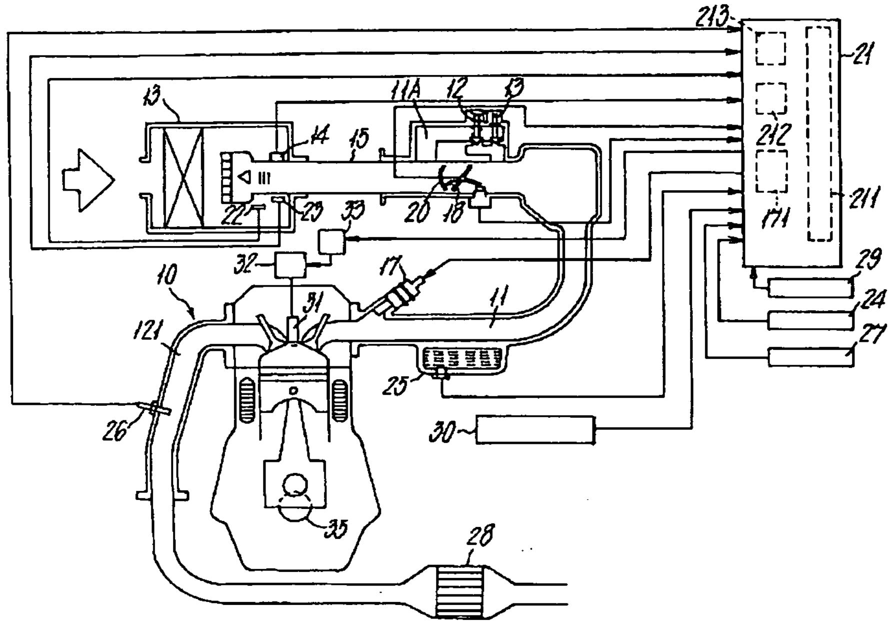
[Drawing 8]



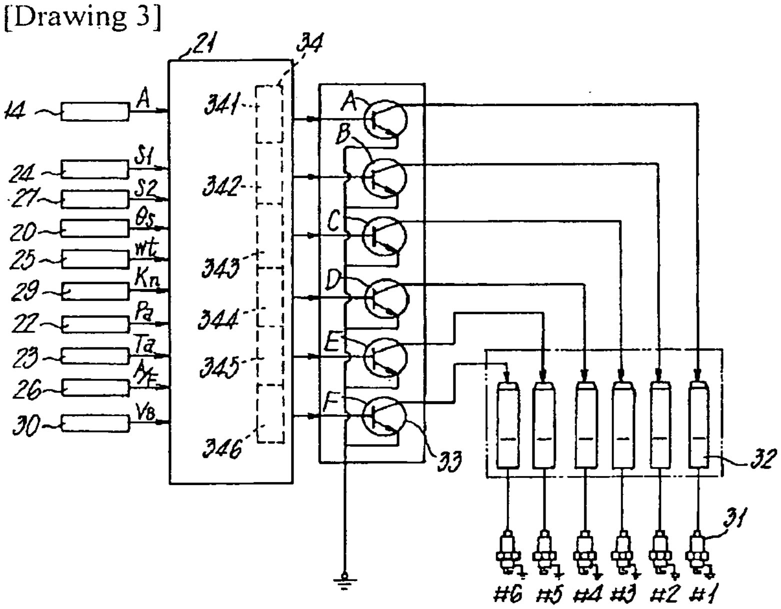
[Drawing 10]



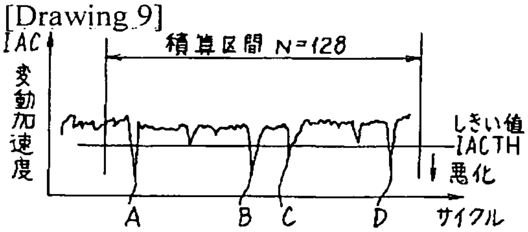
[Drawing 1]



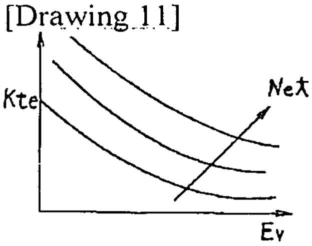
[Drawing 3]



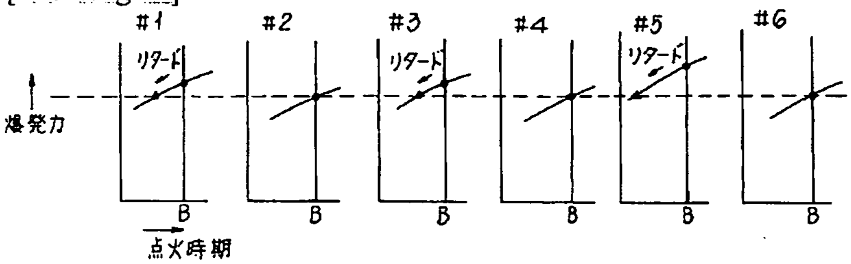
[Drawing 9]



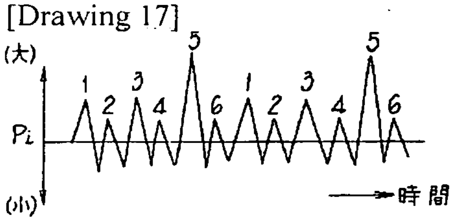
[Drawing 11]



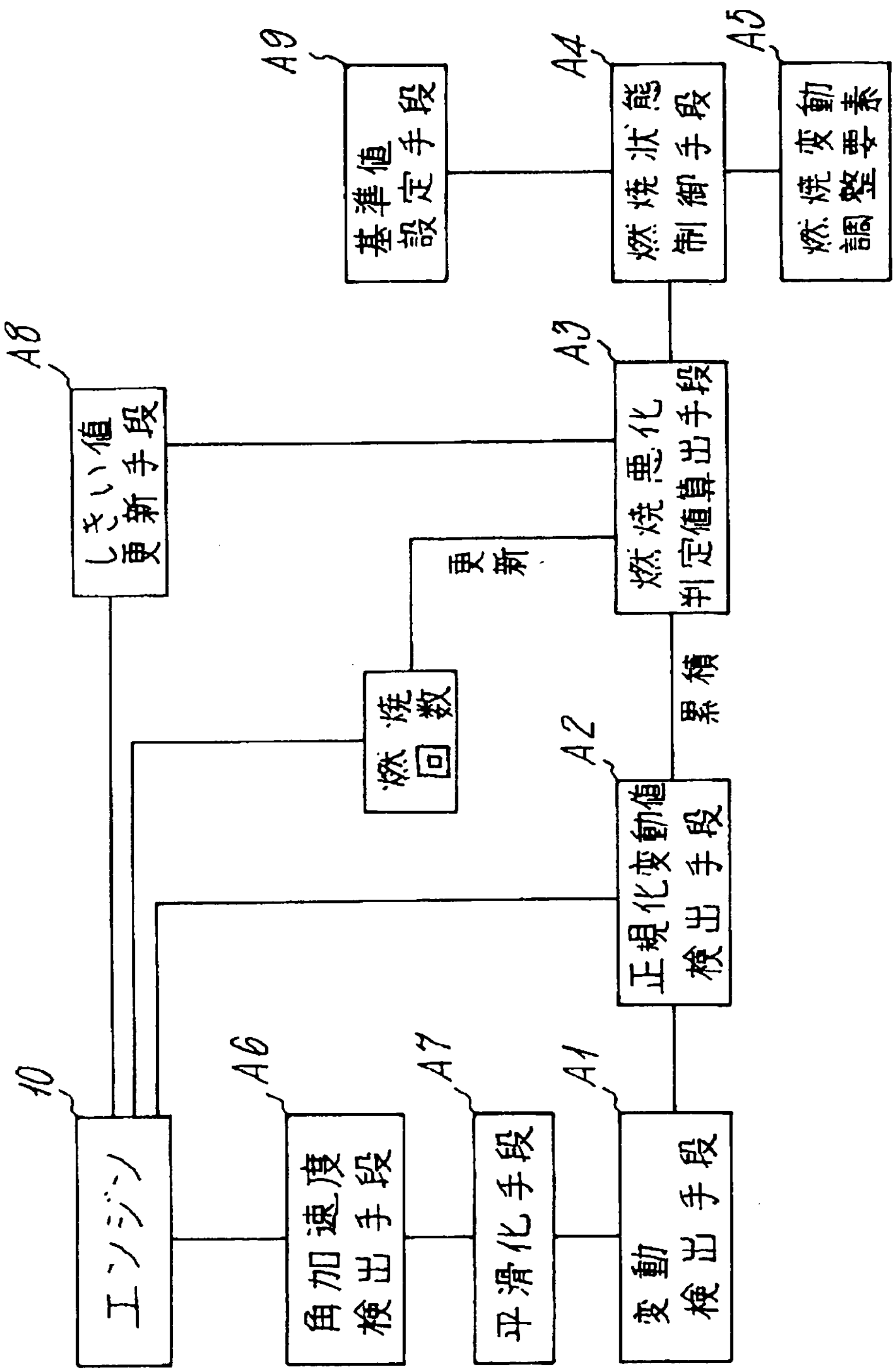
[Drawing 12]



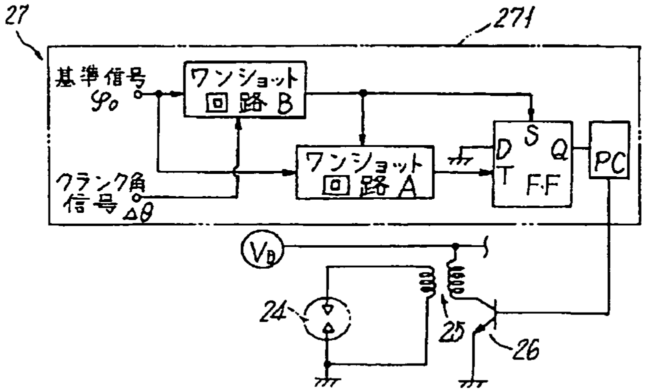
[Drawing 17]



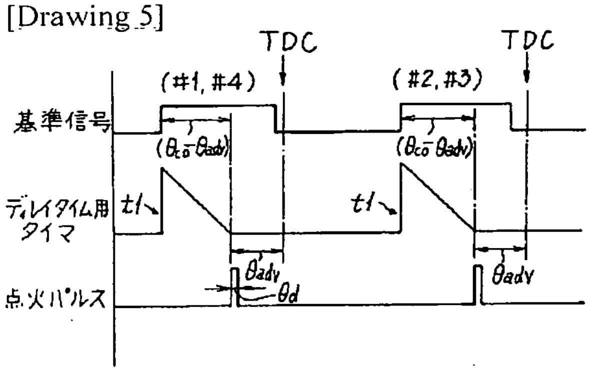
[Drawing 2]


エンジン
10
角加速度検出手段
A6
平滑化手段
A7
変動検出手段
A1
正規化変動値検出手段
A2
燃焼回数
累積
燃焼悪化判定値算出手段
A3
更新
しきい値更新手段
A8
基準値設定手段
A9
燃焼状態制御手段
A4
燃焼変動調整要素
A5

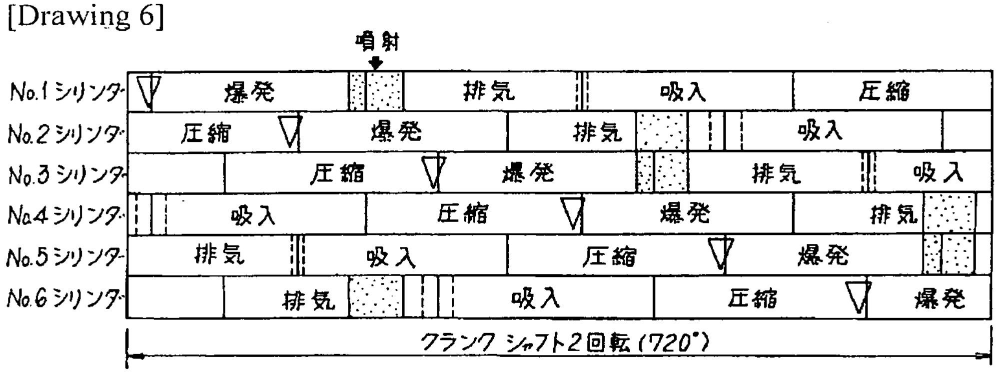
[Drawing 4]



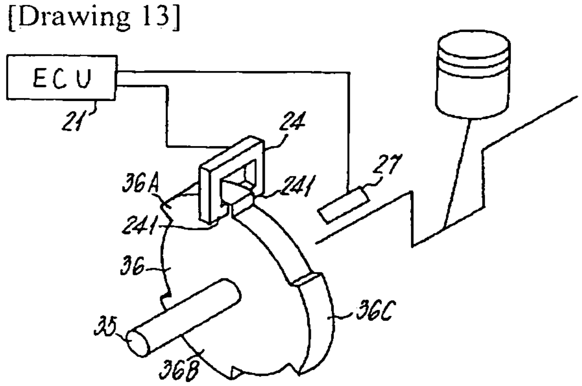
[Drawing 5]



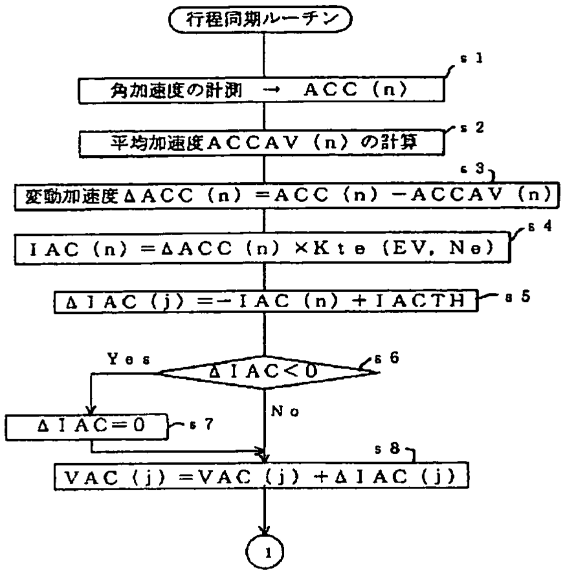
[Drawing 6]



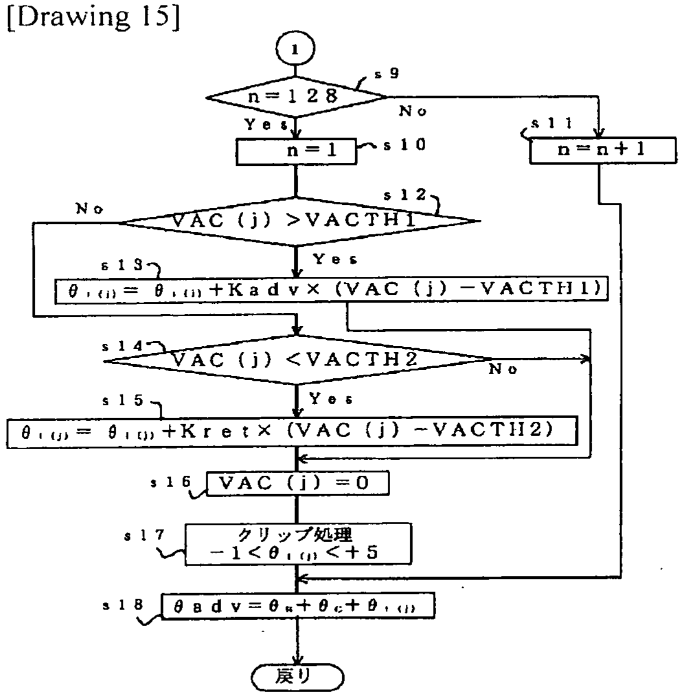
[Drawing 13]



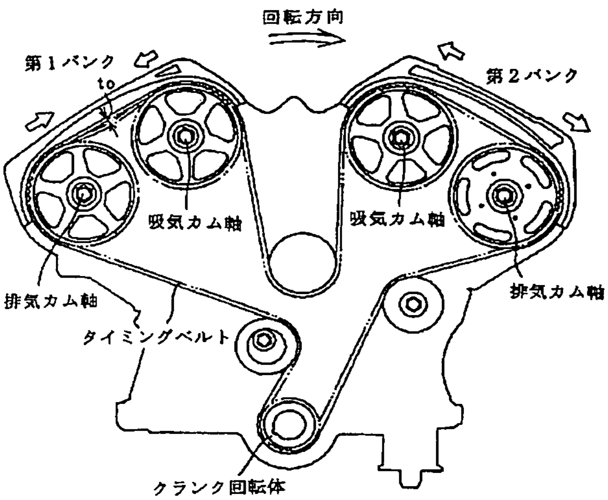
[Drawing 14]



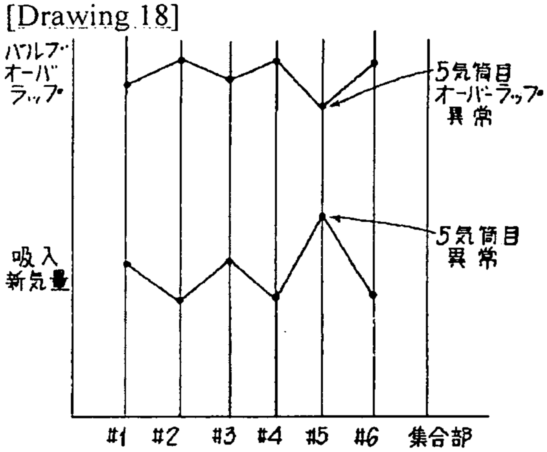
[Drawing 15]



[Drawing 16]



[Drawing 18]



[Translation done.]

* NOTICES *

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 1st partition of the 5th section
[Publication date] August 24, Heisei 11 (1999)

[Publication No.] Publication number 9-32710
[Date of Publication] February 4, Heisei 9 (1997)
[Annual volume number] Open patent official report 9-328
[Application number] Japanese Patent Application No. 7-185550
[International Patent Classification (6th Edition)]

F02P 5/15
F02D 45/00 362

[FI]

F02P 5/15 C
F02D 45/00 362 J

[Procedure revision]
[Filing Date] September 24, Heisei 10
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] The ignition-timing control approach characterized by to amend the ignition timing of the gas column which shows the combustion condition that outputs differ so that the output of other gas columns may approach in the output of the gas column which shows the combustion condition that compare both, judge the combustion condition relevant to the output of each gas column, and outputs differ, after calculate the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizing either this variation or a decision value according to an internal combustion engine's operational status to the ignition timing of other gas columns.
[Claim 2] The ignition-timing control approach characterized by to amend the ignition timing of the gas column which compares both, judges the combustion condition relevant to the output of each gas column, and shows the big combustion condition of an output to a lag side from the ignition timing of the gas column of others which show the small combustion condition of an output after calculate the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizing either this variation or a decision value according to an internal combustion engine's operational status.
[Claim 3] The ignition-timing control approach characterized by to amend the ignition timing of the gas column which compares both, judges the combustion condition relevant to the output of each gas column, and shows the small combustion condition of an output to a tooth-lead-angle side from the

ignition timing of the gas column of others which show the big combustion condition of an output after calculate the variation of an internal combustion engine's angle-of-rotation acceleration for every gas column and normalizing either this variation or a decision value according to an internal combustion engine's operational status.
[Claim 4] In the ignition timing control approach according to claim 1 to 3,
The variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration is characterized by searching for an internal combustion engine's operational status at the time of idle operation.
[Claim 5] In the ignition timing control approach according to claim 1 to 3,
The variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration is characterized by asking using angular velocity at the moment of the ability setting to the instantaneous rotation angular velocity and the bottom dead point in a top dead center.
[Claim 6] In the ignition timing control approach according to claim 1 to 3,
The normalization of either the variation of the above-mentioned angle-of-rotation acceleration or a decision value is characterized by carrying out by amending according to an internal combustion engine's engine speed and inhalation-of-air information.
[Claim 7] In the ignition timing control approach according to claim 1 to 3,
After carrying out the above-mentioned normalization, an angle-of-rotation acceleration variation is compared with a decision value, and it asks for the count to which an angle-of-rotation acceleration variation exceeds a decision value, and it is characterized by amending ignition timing to a tooth-lead-angle side, so that the count is large.
[Claim 8] In the ignition timing control approach according to claim 1 to 3,
either of the variation of the above-mentioned angle-of-rotation acceleration, and a decision value -- it is characterized by changing another side according to engine operational status.
[Claim 9] A fluctuation detection means to detect the variation of an internal combustion engine's angle-of-rotation acceleration,
A normalizing-value detection means to normalize either the variation detected with the above-mentioned fluctuation detection means, or a decision value according to the above-mentioned internal combustion engine's operational status, and to calculate a normalization variation or a normalization decision value,
A combustion aggravation decision value calculation means to compare the above-mentioned normalization variation or a normalization decision value, the above-mentioned variation, or a decision value, and to calculate a combustion aggravation decision value,
The electronic spark timing controller characterized by having an ignition control means to control an ignition drive circuit that the ignition timing of the gas column which shows the combustion condition that outputs differ so that the output of other gas columns may be approached with reference to the above-mentioned combustion aggravation decision value in the output of the combustion condition **** gas column from which an output differs should be amended to the ignition timing of other gas columns.
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0012
[Method of Amendment] Modification
[Proposed Amendment]
[0012] In invention of claim 5, the variation of the above-mentioned internal combustion engine's angle-of-rotation acceleration can also be supposed that it asks for angle-of-rotation acceleration from the instantaneous rotation angular velocity in a top dead center, and the instantaneous rotation angular velocity in a bottom dead point, and the variation of angle-of-rotation acceleration is calculated from the deflection of this angle-of-rotation acceleration and its average.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Modification
[Proposed Amendment]
[0013] In invention of claim 5, it can also be supposed that this average of the above-mentioned

angle-of-rotation acceleration is asked by weighting of the angle-of-rotation acceleration called for this time and the average to last time.
[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0014
[Method of Amendment] Modification
[Proposed Amendment]
[0014] It is characterized by the normalization of either the variation of the above-mentioned angle-of-rotation acceleration or a decision value performing invention of claim 6 in the ignition timing control approach according to claim 1 to 3 by amending according to an internal combustion engine's engine speed and inhalation-of-air information.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0015
[Method of Amendment] Modification
[Proposed Amendment]
[0015] In invention of claim 6, it can also be supposed that it is volumetric efficiency the above-mentioned inhalation-of-air information.
[Procedure amendment 6]
[Document to be Amended] Specification
[Item(s) to be Amended] 0016
[Method of Amendment] Modification
[Proposed Amendment]
[0016] In the ignition timing control approach according to claim 1 to 3, after it carries out the above-mentioned normalization, invention of claim 7 compares an angle-of-rotation acceleration variation with a decision value, asks for the count to which an angle-of-rotation acceleration variation exceeds a decision value, and it is characterized by amending ignition timing to a tooth-lead-angle side, so that the count is large.
[Procedure amendment 7]
[Document to be Amended] Specification
[Item(s) to be Amended] 0017
[Method of Amendment] Modification
[Proposed Amendment]
[0017] Also suppose that the tooth lead angle of ignition timing, maintenance, and the change of a lag are performed according to the count of the above in invention of claim 7.
[Procedure amendment 8]
[Document to be Amended] Specification
[Item(s) to be Amended] 0018
[Method of Amendment] Modification
[Proposed Amendment]
[0018] In invention of claim 7, when the count of the above is more than the 1st count of a judgment, the tooth lead angle of the ignition timing can be carried out, when the count of the above is smaller than the 2nd count of a judgment smaller than the count of a judgment of the above 1st, the lag of the ignition timing can be carried out, and the count of the above can also presuppose that ignition timing is held at the time more than the count of a judgment of the above 2nd smaller than the above-mentioned count of the 1st judgment.
[Procedure amendment 9]
[Document to be Amended] Specification
[Item(s) to be Amended] 0019
[Method of Amendment] Modification
[Proposed Amendment]
[0019] invention of claim 8 -- the ignition timing control approach according to claim 1 to 3 -- setting -- either of the variation of the above-mentioned angle-of-rotation acceleration, and a decision value -- it is characterized by changing another side according to engine operational status.
[Procedure amendment 10]

[Document to be Amended] Specification
[Item(s) to be Amended] 0020
[Method of Amendment] Modification
[Proposed Amendment]
[0020] invention of claim 8 -- setting -- either of the variation of the above-mentioned angle-of-rotation acceleration, and a decision value -- also suppose that another side is changed according to an engine speed and inhalation-of-air information.
[Procedure amendment 11]
[Document to be Amended] Specification
[Item(s) to be Amended] 0021
[Method of Amendment] Modification
[Proposed Amendment]
[0021] In invention of claim 8, it can also be supposed that it is volumetric efficiency the above-mentioned inhalation-of-air information.
[Procedure amendment 12]
[Document to be Amended] Specification
[Item(s) to be Amended] 0022
[Method of Amendment] Modification
[Proposed Amendment]
[0022] A fluctuation detection means by which invention of claim 9 detects the variation of an internal combustion engine's angle-of-rotation acceleration, A normalizing-value detection means to normalize either the variation detected with the above-mentioned fluctuation detection means, or a decision value according to the above-mentioned internal combustion engine's operational status, and to calculate a normalization variation or a normalization decision value, A combustion aggravation decision value calculation means to compare the above-mentioned normalization variation or a normalization decision value, the above-mentioned variation, or a decision value, and to calculate a combustion aggravation decision value, It is characterized by having an ignition control means to control an ignition drive circuit that the ignition timing of the gas column which shows the combustion condition that outputs differ so that the output of other gas columns may be approached with reference to the above-mentioned combustion aggravation decision value in the output of the combustion condition **** gas column from which an output differs should be amended to the ignition timing of other gas columns.
[Procedure amendment 13]
[Document to be Amended] Specification
[Item(s) to be Amended] 0083
[Method of Amendment] Modification
[Proposed Amendment]
[0083] In invention of claim 5 the variation of an internal combustion engine's angle-of-rotation acceleration Since it asks for angle-of-rotation acceleration from the instantaneous rotation angular velocity in a top dead center, and the instantaneous rotation angular velocity in a bottom dead point and the variation of angle-of-rotation acceleration is calculated from the deflection of this angle-of-rotation acceleration and its average when it is made calculating [the variation of angle-of-rotation acceleration]-comparatively easily appearance, the variation of angle-of-rotation acceleration can be calculated certainly, and car-body vibration can be prevented more certainly -- effectiveness [like] can be acquired.
[Procedure amendment 14]
[Document to be Amended] Specification
[Item(s) to be Amended] 0084
[Method of Amendment] Modification
[Proposed Amendment]
[0084] in invention of claim 5, the dependability of the variation of the computed angle-of-rotation acceleration increases, and this average of angle-of-rotation acceleration can prevent car-body vibration more certainly, when it is made into asking-by weighting of angle-of-rotation acceleration [which was called for this time] and the average to last time appearance -- effectiveness [like] can be acquired.

[Procedure amendment 15]
[Document to be Amended] Specification
[Item(s) to be Amended] 0085
[Method of Amendment] Modification
[Proposed Amendment]
[0085] In the ignition timing control approach according to claim 1 to 3, especially, since invention of claim 6 amends the normalization of either the variation of angle-of-rotation acceleration, or a decision value according to an internal combustion engine's engine speed and inhalation-of-air information, for example, volumetric efficiency, it can perform this amendment with sufficient responsibility, and the output of the gas column from which an output differs comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented. In addition, the same effectiveness is acquired also when the above-mentioned inhalation-of-air information is made into being [it / volumetric efficiency] appearance.
[Procedure amendment 16]
[Document to be Amended] Specification
[Item(s) to be Amended] 0086
[Method of Amendment] Modification
[Proposed Amendment]
[0086] Invention of claim 7 is set to the ignition timing control approach according to claim 1 to 3. After normalizing especially, an angle-of-rotation acceleration variation is compared with a decision value. Since it asks for the count to which an angle-of-rotation acceleration variation exceeds a decision value, ignition timing is amended to a tooth-lead-angle side, so that that count is large, or the tooth lead angle of ignition timing, maintenance, and the change of a lag are performed, the output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented. In addition, the same effectiveness is acquired also when it is made supposing [it / that the tooth lead angle of ignition timing, maintenance, and the change of a lag are performed according to the count of the above] appearance.
[Procedure amendment 17]
[Document to be Amended] Specification
[Item(s) to be Amended] 0087
[Method of Amendment] Modification
[Proposed Amendment]
[0087] In invention of claim 7, when a count is more than the 1st count of a judgment, the tooth lead angle of the ignition timing is carried out. When a count is smaller than the 2nd count of a judgment smaller than the 1st count of a judgment, the lag of the ignition timing is carried out. Change that a count holds ignition timing at the time more than the 2nd count of a judgment smaller than the count of the 1st judgment may be performed. When the output of the gas column from which an output differs by this amendment makes it approaching [come]-output of other gas columns appearance fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented -- effectiveness [like] can be acquired.
[Procedure amendment 18]
[Document to be Amended] Specification
[Item(s) to be Amended] 0088
[Method of Amendment] Modification
[Proposed Amendment]
[0088] In the ignition timing control approach according to claim 1 to 3, especially as for invention of claim 8, the output of the variation and decision value of angle-of-rotation acceleration it is

[output] the gas column from which an output differs by this modification either since another side is changed according to engine operational status comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.
[Procedure amendment 19]
[Document to be Amended] Specification
[Item(s) to be Amended] 0089
[Method of Amendment] Modification
[Proposed Amendment]
[0089] invention of claim 8 -- setting -- especially -- either of the variation of angle-of-rotation acceleration, and a decision value, since another side is changed according to an engine speed and inhalation-of-air information, for example, volumetric efficiency this amendment can be performed with sufficient responsibility, fluctuation of the output between each gas column can be regulated with responsibility sufficient when the output of the gas column from which an output differs makes it approaching [come]-output of other gas columns appearance, and car-body vibration which originates in the output fluctuation between each gas column can be prevented -- effectiveness [like] can be acquired.
[Procedure amendment 20]
[Document to be Amended] Specification
[Item(s) to be Amended] 0090
[Method of Amendment] Modification
[Proposed Amendment]
[0090] As for invention of claim 9, the variation of an internal combustion engine's angle-of-rotation acceleration is detected by the fluctuation detection means. Either the variation detected with the fluctuation detection means or a decision value is normalized according to an internal combustion engine's operational status by the normalizing-value detection means, and a normalization variation or a normalization decision value is calculated. A normalization variation or a normalization decision value, a variation, or a decision value is compared by the combustion aggravation decision value calculation means, and a combustion aggravation decision value is calculated. With an ignition control means Since an ignition drive circuit is controlled so that the output of the gas column which shows the combustion condition that a combustion aggravation decision value is referred to and outputs differ approaches the output of other gas columns, and the ignition timing of the gas column which shows the combustion condition that outputs differ is amended to the ignition timing of other gas columns The output of the gas column from which an output differs by this amendment comes to approach the output of other gas columns. For this reason, fluctuation of the output between each gas column by gap of the variation in an engine component part and the valve timing of a valve gear system can be regulated with sufficient responsibility, and car-body vibration which originates in the output fluctuation between each gas column can be prevented.

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平9－32710

(43)公開日　平成９年(1997)２月４日

(51)Int.Cl.6	識別記号	庁内整理番号	ＦＩ		技術表示箇所
Ｆ０２Ｐ　5/15			Ｆ０２Ｐ　5/15	Ｃ	
Ｆ０２Ｄ　45/00	３６２		Ｆ０２Ｄ　45/00	３６２Ｊ	

審査請求　未請求　請求項の数16　ＯＬ　（全 16 頁）

(21)出願番号　特願平7－185550

(22)出願日　平成７年(1995)７月21日

(71)出願人　000006286
三菱自動車工業株式会社
東京都港区芝五丁目33番８号

(72)発明者　齋藤　栄
東京都港区芝五丁目33番８号・三菱自動車工業株式会社内

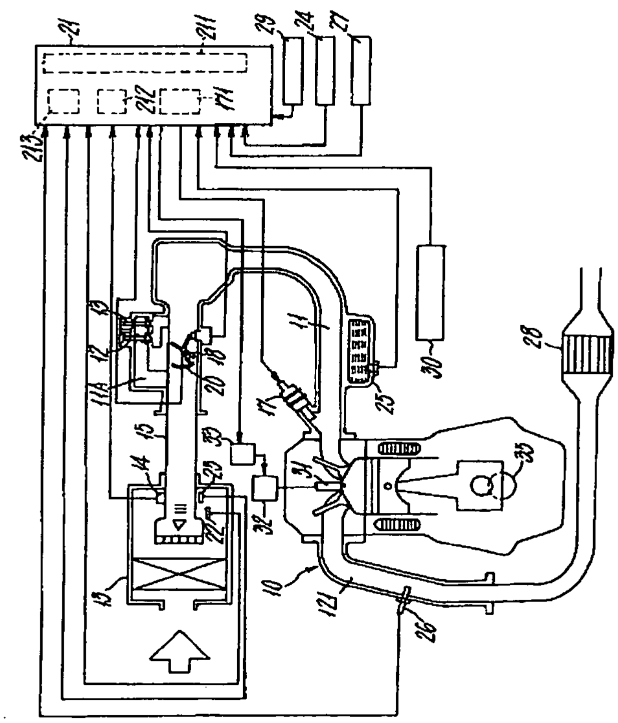
(74)代理人　弁理士　樺山　亨　（外１名）

(54)【発明の名称】　点火時期制御方法及びその装置

(57)【要約】

【課題】　エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を規制し、この各気筒間の出力変動に基因する車体振動を排除出来る点火時期制御方法及びその装置を提供することにある。

【解決手段】　エンジン１０の回転角加速度ω’の変動値ΔＡＣＣ（ｎ）を各気筒毎に求め、この変動値または判定値のいずれか一方を内燃機関の運転状態に応じて正規化ＩＡＣ（ｎ）した後、両者を比較して各気筒の出力に関連する燃焼状態を判定し、出力の異なる燃焼状態示す気筒の出力をその他の気筒の出力に近づくように出力の異なる燃焼状態を示す気筒の点火時期θａｄｖをその他の気筒の点火時期に対し補正する。



【特許請求の範囲】

【請求項１】内燃機関の回転角加速度の変動値を各気筒毎に求め、この変動値または判定値のいずれか一方を内燃機関の運転状態に応じて正規化した後、両者を比較して各気筒の出力に関連する燃焼状態を判定し、出力の異なる燃焼状態を示す気筒の出力をその他の気筒の出力に近づくように出力の異なる燃焼状態を示す気筒の点火時期をその他の気筒の点火時期に対し補正することを特徴とする点火時期制御方法。

【請求項２】内燃機関の回転角加速度の変動値を各気筒毎に求め、この変動値または判定値のいずれか一方を内燃機関の運転状態に応じて正規化した後、両者を比較して各気筒の出力に関連する燃焼状態を判定し、出力の大きな燃焼状態を示す気筒の点火時期を出力の小さな燃焼状態を示すその他の気筒の点火時期より遅角側に補正することを特徴とする点火時期制御方法。

【請求項３】内燃機関の回転角加速度の変動値を各気筒毎に求め、この変動値または判定値のいずれか一方を内燃機関の運転状態に応じて正規化した後、両者を比較して各気筒の出力に関連する燃焼状態を判定し、出力の小さな燃焼状態を示す気筒の点火時期を出力の大きな燃焼状態を示すその他の気筒の点火時期より進角側に補正することを特徴とする点火時期制御方法。

【請求項４】請求項１乃至請求項３記載の点火時期制御方法において、

上記内燃機関の回転角加速度の変動値は、内燃機関の運転状態がアイドル運転時に求められることを特徴とする。

【請求項５】請求項１乃至請求項３記載の点火時期制御方法において、

上記内燃機関の回転角加速度の変動値は、上死点における瞬間回転角速度と下死点における瞬間角速度とを用いて求めることを特徴とする。

【請求項６】請求項５記載の点火時期制御方法において、

上記内燃機関の回転角加速度の変動値は、上死点における瞬間回転角速度と下死点における瞬間回転角速度とから回転角加速度を求め、この回転角加速度とその平均値との偏差から回転角加速度の変動値を求めることを特徴とする。

【請求項７】請求項６記載の点火時期制御方法において、

上記回転角加速度の今回の平均値は、今回求められた回転角速度と前回までの平均値との重み付けにより求めることを特徴とする。

【請求項８】請求項１乃至請求項３記載の点火時期制御方法において、

上記回転角加速度の変動値または判定値のいずれか一方の正規化は、内燃機関のエンジン回転数及び吸気情報に応じて補正することにより行うことを特徴とする。

【請求項９】請求項８記載の点火時期制御方法において、

上記吸気情報は体積効率であることを特徴とする。

【請求項１０】請求項１乃至請求項３記載の点火時期制御方法において、

上記正規化を実施した後、回転角加速度変動値と判定値とを比較し、回転角加速度変動値が判定値を上回る回数を求め、その回数が大きいほど点火時期を進角側に補正することを特徴とする。

【請求項１１】請求項１０記載の点火時期制御方法において、

上記回数に応じて点火時期の進角、保持、遅角の切換えを行うことを特徴とする。

【請求項１２】請求項１１記載の点火時期制御方法において、

上記回数が第１の判定回数以上のとき点火時期を進角し、上記回数が上記第１の判定回数より小さい第２の判定回数より小さいとき点火時期を遅角し、上記回数が上記第１判定回数より小さく且つ上記第２の判定回数以上のときに点火時期を保持することを特徴とする。

【請求項１３】請求項１乃至請求項３記載の点火時期制御方法において、

上記回転角加速度の変動値と判定値とのいずれか他方をエンジンの運転状態に応じて変更することを特徴とする。

【請求項１４】請求項１３記載の点火時期制御方法において、

上記回転角加速度の変動値と判定値とのいずれか他方をエンジン回転数と吸気情報に応じて変更することを特徴とする。

【請求項１５】請求項１４記載の点火時期制御方法において、

上記吸気情報は体積効率であることを特徴とする。

【請求項１６】内燃機関の回転角加速度の変動値を検出する変動検出手段と、

上記変動検出手段で検出された変動値または判定値のいずれか一方を上記内燃機関の運転状態に応じて正規化して正規化変動値または正規化判定値を求める正規化値検出手段と、

上記正規化変動値または正規化判定値と上記変動値または判定値とを比較して燃焼悪化判定値を求める燃焼悪化判定値算出手段と、

上記燃焼悪化判定値を参照して、出力の異なる燃焼状態示す気筒の出力をその他の気筒の出力に近づくように出力の異なる燃焼状態を示す気筒の点火時期をその他の気筒の点火時期に対し補正すべく点火駆動回路を制御する点火制御手段とを備えたことを特徴とする点火時期制御装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、多気筒のエンジンの点火時期制御方法及びその装置、特に、各気筒間での燃焼のバラツキを規制するようにした点火時期制御方法及びその装置に関する。

【０００２】

【従来の技術】多気筒のエンジンの点火系では、適正点火順序で各気筒の点火処理を行い、各気筒に順次出力トルクを発生させ、エンジン回転を継続させている。このエンジンの点火系は、各気筒の圧縮上死点前の所定クランク角を点火時期としてエンジン運転状態に応じて順次算出し、同点火時期に点火回路を駆動し各気筒の点火を行っている。この点火時期の基本的な制御では、エンジンの定常運転時において運転条件、例えば、エンジン回転数、吸入空気量等に応じて基準点火時期を設定し、これをノッキングの発生しない範囲で、適宜補正し、目標点火時期を求め、同点火時期に点火処理を行なっている。

【０００３】このような点火時期の制御により、各気筒の発生する出力は、基準の点火時期を進める（アドバンス）ことにより増加し、遅角する（リタード）ことにより減少することが知られている。

【０００４】

【発明が解決しようとする課題】ところで、多気筒のエンジンでは、部品バラツキや、動弁系のベルトトレーンの撓みなどが原因してバルブタイミングがずれ、気筒毎の空燃比が変動するという問題がある。例えば、図１６に示すＤＯＨＣ式のエンジンでは、第１バンクと第２バンクに気筒を配置すると共に、示矢する方向を回転方向とするタイミングベルトによって第１バンク側の排気カム軸、吸気カム軸、アイドラがこの順で回転され、次いで、第２バンク側の吸気カム軸、排気カム軸、クランク軸側回転体がこの順で回転される。

【０００５】このようなＤＯＨＣ式のエンジンでは、図１７、図１８に示すような出力変動が生じる。即ち、このＤＯＨＣ式のＶ型エンジンでは、その駆動時に左右バンクの吸排気カム軸がタイミングベルトによって同時駆動されるが、各弁バネの閉弁付勢力及びオーバーラップ位置のカム形状によって、吸排気カム軸には回転を進める方向あるいは回転を遅らす方向への力が生じ、これがタイミングベルトに対し伸縮方向の変位を生じさせる。この結果、特に、第１バンクでのタイミングベルトの撓みｔ０の傾向が大きく表れ、オーバーラップ量が正規の値より小さくなる。このようにオーバーラップ量が小さくなった第１バンクでは、アイドル時のような低速回転域であると吹き抜けが低下し出力が向上し、逆に、高速回転域であると体積効率が低下して出力低下を招くという問題がある。これに加え、部品バラツキによって特定気筒（ここでは＃５気筒）の出力（図示平均有効圧Ｐｉ）が所定の運転域で比較的大きくなっている。

【０００６】このように各気筒間の空燃比のずれ等により、気筒毎の燃焼時の出力が微妙に増減変動し、これが原因して車体に振動を励起してしまい、乗員に不快感を与えるという問題がある。本発明の目的は、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を規制し、この各気筒間の出力変動に起因する車体振動を排除出来る点火時期制御方法及びその装置を提供することにある。

【０００７】

【課題を解決するための手段】上述の目的を達成するために、請求項１の発明は、内燃機関の回転角加速度の変動値を各気筒毎に求め、この変動値または判定値のいずれか一方を内燃機関の運転状態に応じて正規化した後、両者を比較して各気筒の出力に関連する燃焼状態を判定し、出力の異なる燃焼状態を示す気筒の出力をその他の気筒の出力に近づくように出力の異なる燃焼状態を示す気筒の点火時期をその他の気筒の点火時期に対し補正することを特徴とする点火時期制御方法。

【０００８】請求項２の発明は、内燃機関の回転角加速度の変動値を各気筒毎に求め、この変動値または判定値のいずれか一方を内燃機関の運転状態に応じて正規化した後、両者を比較して各気筒の出力に関連する燃焼状態を判定し、出力の大きな燃焼状態示す気筒の点火時期を出力の小さな燃焼状態示すその他の気筒の点火時期より遅角側に補正することを特徴とする。

【０００９】請求項３の発明は、内燃機関の回転角加速度の変動値を各気筒毎に求め、この変動値または判定値のいずれか一方を内燃機関の運転状態に応じて正規化した後、両者を比較して各気筒の出力に関連する燃焼状態を判定し、出力の小さな燃焼状態を示す気筒の点火時期を出力の大きな燃焼状態を示すその他の気筒の点火時期より進角側に補正することを特徴とする。

【００１０】請求項４の発明は、請求項１乃至請求項３記載の点火時期制御方法において、上記内燃機関の回転角加速度の変動値は、内燃機関の運転状態がアイドル運転時に求められることを特徴とする。

【００１１】請求項５の発明は、請求項１乃至請求項３記載の点火時期制御方法において、上記内燃機関の回転角加速度の変動値は、上死点における瞬間回転角速度と下死点における瞬間回転角速度とを用いて求めることを特徴とする。

【００１２】請求項６の発明は、請求項５記載の点火時期制御方法において、上記内燃機関の回転角加速度の変動値は、上死点における瞬間回転角速度と下死点における瞬間回転角速度とから回転角加速度を求め、この回転角加速度とその平均値との偏差から回転角加速度の変動値を求めることを特徴とする。

【００１３】請求項７の発明は、請求項６記載の点火時期制御方法において、上記回転角加速度の今回の平均値は、今回求められた回転角加速度と前回までの平均値との重み付けにより求めることを特徴とする。

【００１４】請求項８の発明は、請求項１乃至請求項３記載の点火時期制御方法において、上記回転角加速度の変動値または判定値のいずれか一方の正規化は、内燃機関のエンジン回転数及び吸気情報に応じて補正することにより行うことを特徴とする。

【００１５】請求項９の発明は、請求項８記載の点火時期制御方法において、上記吸気情報は体積効率であることを特徴とする。

【００１６】請求項１０の発明は、請求項１乃至請求項３記載の点火時期制御方法において、上記正規化を実施した後、回転角加速度変動値と判定値とを比較し、回転角加速度変動値が判定値を上回る回数を求め、その回数が大きいほど点火時期を進角側に補正することを特徴とする。

【００１７】請求項１１の発明は、請求項１０記載の点火時期制御方法において、上記回数に応じて点火時期の進角、保持、遅角の切換えを行うことを特徴とする。

【００１８】請求項１２の発明は、請求項１１記載の点火時期制御方法において、上記回数が第１の判定回数以上のとき点火時期を進角し、上記回数が上記第１の判定回数より小さい第２の判定回数より小さいとき点火時期を遅角し、上記回数が上記第１判定回数より小さく且つ上記第２の判定回数以上のときに点火時期を保持することを特徴とする。

【００１９】請求項１３の発明は、請求項１乃至請求項３記載の点火時期制御方法において、上記回転角加速度の変動値と判定値とのいずれか他方をエンジンの運転状態に応じて変更することを特徴とする。

【００２０】請求項１４の発明は、請求項１３記載の点火時期制御方法において、上記回転角加速度の変動値と判定値とのいずれか他方をエンジン回転数と吸気情報に応じて変更することを特徴とする。

【００２１】請求項１５の発明は、請求項１４記載の点火時期制御方法において、上記吸気情報は体積効率であることを特徴とする。

【００２２】請求項１６の発明は、内燃機関の回転角加速度の変動値を検出する変動検出手段と、上記変動検出手段で検出された変動値または判定値のいずれか一方を上記内燃機関の運転状態に応じて正規化して正規化変動値または正規化判定値を求める正規化値検出手段と、上記正規化変動値または正規化判定値と上記変動値または判定値とを比較して燃焼悪化判定値を求める燃焼悪化判定値算出手段と、上記燃焼悪化判定値を参照して、出力の異なる燃焼状態示す気筒の出力をその他の気筒の出力に近づくように出力の異なる燃焼状態を示す気筒の点火時期をその他の気筒の点火時期に対し補正すべく点火駆動回路を制御する点火制御手段とを備えたことを特徴とする。

【００２３】

【実施例】以下、本発明の一実施例としての点火時期制御方法及びその装置に付いて説明する。この点火時期制御装置はＤＯＨＣ式の６気筒の内燃機関（以下単にエンジン１０と記す）に装着される。このエンジン１０には吸気路１１及び排気路１２が接続される。この吸気路１１はエアクリーナ１３よりのエアを吸入し、エアフローセンサ１４によりその空気量を検出し、吸気管１５を介してエンジンの燃焼室に導いている。尚、吸気路１１の途中にはサージタンク１６がありその下流側にはエンジン１０に支持された燃料噴射弁１７より燃料供給がなされている。

【００２４】吸気路１１はスロットルバルブ１８により開閉され、さらに、このスロットルバルブ１８をバイパスするバイパス通路１１Ａが設けられ、このバイパス路１１Ａには、ＩＳＣ弁として機能する捨てっぱステッパモータ弁（ＳＴＭ弁）１２が介装されている。なお、このバイパス通路１１Ａには、エンジン冷却水温に応じて開度が調整されるワックスタイプのファーストアイドルエアバルブ１３も設けられており、ＳＴＭ弁１２に併設されている。ＳＴＭ弁１２の開度を後述するエンジンコントロールユニット（以後単にＥＣＵと記す）２１にて制御することにより、運転者によるアクセルペダルの操作とは関係無く、バイパス通路１１Ａを通して吸気をエンジン１０に供給することができる。

【００２５】このスロットルバルブ１８には同バルブの開度ｓθ情報を出力するスロットルセンサ２０が付設され、同センサの電圧値がＥＣＵ２１の入出力回路２１２に図示しないＡ／Ｄ変換器を介して入力されている。ここで、符号２２は大気圧Ｐａを出力する大気圧センサを、符号２３は大気温Ｔａを出力する大気温センサを、符号２５はエンジン１０の水温信号ｗｔを出力する水温センサを示している。エンジンの排気路１２には実空燃比（Ａ／Ｆ）を出力するリニアＡ／Ｆセンサ２６が装着され、更に、リニアＡ／Ｆセンサ２６の下流に三元触媒２８が配設され、その下流には図示しないマフラーが配設されている。

【００２６】三元触媒２８は触媒活性温度に達した際に、排ガスがストイキオ中心のウインドウ域にあると、ＨＣ，ＣＯ，ＮＯｘの酸化還元処理を行なうことができ、無害化された排ガスを排気出来る。なお、場合により、酸素過剰下でＮＯｘを還元することができるリーンＮＯｘ触媒を付加しても良い。更に、エンジン１０は各気筒毎に点火プラグ３１を装着され、各気筒＃１～＃６のプラグ３１は点火駆動手段としての点火コイル３２、パワートランジスタ３３、駆動回路３４及びＥＣＵ２１に接続される。点火駆動回路３４は各気筒毎に図３、図４に示す点火駆動部３４１（３４２～３４６は同様構成のため図示せず）を備える。

【００２７】ここでの点火駆動部３４１はクランク角信号(クランク角センサ信号ｓ１に基づき検出されたΔθ)と、基準信号（ＴＤＣセンサ信号ｓ２に基づき検出され

たφｏ）とによって駆動する。ここで、目標点火時期φtが決定された定常運転時において、ワンショット回路Ｂは上死点前（例えば７５°）の基準信号φｏによりトリガされ、クランク角信号Δθを決められた数（点火時期φｏ－φtに相当するディレイタイムｔ1）だけ数えた後に通電開始信号を出力するように構成される（図５参照）。この場合、目標点火時期φtは後述する図１５のフローチャートのステップｓ１８で符号θａｄｖとして求められたものである。

【００２８】ワンショット回路Ａはその通電開始信号によりトリガされ、ドエル角θｄに相当するクランク角信号を決められた数だけ数え点火信号を出力するよう構成される。フリップフロップＦ・ＦはワンショットＢからの通電開始信号によりセットされて、ワンショット回路Ａからの点火信号によりリセットされる。更に、駆動回路ＰＣはフリップフロップのセット状態時にその出力信号によりパワートランジスタ３３をオンさせて、イグニッションコイル３２への電流を流させる。イグニッションコイル３２はパワートランジスタ３３がオフした時に二次側に高圧電流を生じさせ、この電流が第１気筒＃１の点火プラグ３１に伝えられ、点火が行なわれる。

【００２９】同様に、第２～第６気筒＃２～＃６の点火駆動部３４２～３４６も構成され、目標点火時期φtに対向する気筒のイグニッションコイル３２の二次側高圧電流が各気筒＃２，＃３の点火プラグ３１に供給され、各気筒の点火が行なわれる。なお、図６に全気筒＃１～＃６の基準点火時期の一例を示した。ここで、各気筒の点火時期は、ほぼクランク角１２０°の間隔を保って各気筒毎に交互に行われている。ここでのエンジン１０のクランク軸３５には図１３に示すようにクランク角センサ信号ｓ１（クランク角信号Δθ，エンジン回転数Ｎｅの算出に用いる）を出力するクランク角センサ２４と、ＴＤＣセンサ信号ｓ２（基準信号φの算出に用いる）を出力するＴＤＣセンサ２７とが装着され、更に、エンジン１０にはノック信号Ｋｓを出力するノックセンサ２９が装着され、バッテリー電圧センサ３０も装備される。

【００３０】尚、これらセンサ類である、エアフローセンサ１４、スロットルセンサ２０、大気圧センサ２２、大気温センサ２３、クランク角センサ２４、水温センサ２５、リニアＡ／Ｆセンサ２６、ＴＤＣセンサ２７、ノックセンサ２９、バッテリー電圧センサ３０等よりの出力信号がＥＣＵ２１の入出力回路２１１に入力されている。エンジンコントロールユニットであるＥＣＵ２１はマイクロコンピュータによってその要部が形成され、上述の駆動回路１７１と、入出力回路２１１と、図１４乃至図１５の制御プログラムや各設定値や図８、図１１の各算出マップやその他の設定値等を格納処理された記憶回路２１２と、制御プログラムに沿って燃料噴射弁１７及び点火プラグ３１を駆動制御する制御回路２１３とを備え、エンジン１０への燃料供給制御、スロットル弁駆動制御等の周知の制御処理を行うと共に点火時期制御を行う。

【００３１】なお、ここでの燃料供給制御では吸入空気量に基づく基本燃料パルス幅Ｔｆを算出し、これに空燃比その他の補正係数を掛けてインジェクタ駆動時間を決定し、各気筒のインジェクタを駆動させるという周知のインジェクタ駆動制御処理を行う。ここで、いま、点火時期制御に着目すると、この点火時期制御のために、ＥＣＵ２１はこのＥＣＵ２１は、図２に示すように、変動検出手段Ａ１、正規化変動値検出手段Ａ２、燃焼悪化判定値算出手段Ａ３、燃焼状態制御手段Ａ４、燃焼変動要素Ａ５、角加速度検出手段Ａ６、平滑化手段Ａ７、閾値更新手段Ａ８及び基準値設定手段Ａ９の機能を備える。

【００３２】ここで、燃焼変動要素Ａ５は、燃焼状態制御手段Ａ４からの制御信号により点火時期をθａｄｖを所望の状態に調整して、実現すべき出力での運転を行うもので、点火プラグ３１が燃焼変動要素Ａ５として機能する。なお、点火時期（制御点火時期）θａｄｖは次式で表される。

$\theta adv = \theta_B + \theta_C + \theta_{I(j)}$

この式におけるθBは基本点火時期であり、体積効率Ｅｖとエンジン回転数Ｎｅで決まる値で、所定のマップで演算される。体積効率Ｅｖは、エアフローセンサ１４からの吸入空気量Ａとクランク角センサ２４からのエンジン回転数Ｎとからエンジン１回転当たりの吸入空気量Ａ／Ｎを求め、この情報に基づき体積効率Ｅｖが算出されている。

【００３３】θCはエンジン冷却水温度ｗｔ、吸気温度Ｔａ、大気圧Ｐａ等に応じた各種点火時期補正値である。θI(j) は、後述のように燃焼変動に対応した点火時期制御を行うための燃焼変動補正値である。ところで、本実施例の点火時期制御装置は、エンジンに駆動されるクランク軸３５の角加速度を検出する角加速度検出手段Ａ６を備え、角加速度検出手段Ａ６は次のように構成される。

【００３４】即ち、図１３に示すように、角加速度検出手段Ａ６は、クランク角センサ２４、ＴＤＣセンサ２７及びＥＣＵ２１を主要素として備え、クランク角センサ２４はクランク軸３５と一体的に回転する回転部材３６をそなえる。回転部材３６はその周辺に半径方向に突出する第１～３のベーン３６Ａ～３６Ｃを形成され、これら第１～３のベーンに対して両面から対向するように装備された検出部２４１が回転部材３６の回動に伴うら第１～３のベーンの通過を、光学的にもしくは電磁気的に検出し、対応するパルス出力を行うように構成されている。第１～３のベーン３６Ａ～３６Ｃは、各々が一定角度のクランク軸回転角度に対応する周方向長さを備え、所定角度間隔毎に、周方向に離隔して配設されている。

【００３５】即ち、隣合うベーンの対向縁は相互に１２０度の角度間隔を持って配設されている。ところで、Ｔ

ＤＣセンサ２７は、図示しないカムシャフトに固着されており、クランク軸３５が２回転してカムシャフトが１回転する間に、カムシャフトが１つの気等に対向する特定の回転位置を採る毎に、パルス出力を発生するように成ってる。そして、点火作動が気筒番号順に行われる６気筒エンジンに搭載された本装置は、例えば第３のベーン３６Ｃの縁部（前端または後端）が検出部２４１を通過したときに、第１気筒グループをなす第１気筒及び第４気筒の何れか一方に対応する第１クランク軸回転角度領域にクランク軸が突入すると共に、第１ベーン３６Ａの端縁が検出部２４１を通過した時に、クランク軸が第１回転角度領域から離脱するようになっている。

【００３６】同様に、第１ベーン３６Ａの端縁の通過時に、第２気筒グループをなす第２気筒及び第５気筒の何れか一方に対応する第２クランク軸回転角度領域に突入し、次いで、第２ベーン３６Ｂの端縁の通過時に第３気筒グループをなす第３気筒及び第６気筒の何れか一方に対応する第３クラン回転角度領域に突入し、次いで、第３ベーン３６Ｃの端縁の通過時に同領域からの離脱が行われるようになっている。そして、第１気筒と第４気筒との識別、第２気筒と第５気筒との識別、第３気筒と第６気筒との識別は、ＴＣＤセンサ２７の出力に基づいて行われるようになっている。このような構成により、角加速度の検出は次ののように行われている。

【００３７】即ち、エンジン回転数中、ＥＣＵ２１はクランク角センサ２４からのパルス出力とＴＤＣセンサ２７の検出信号とを逐次入力され、演算を周期的に繰り返し実行する。またＥＣＵ２１はクランク角センサ２４からのパルス出力が、ＴＤＣセンサ２７からのパルス出力の入力時点以降に順次入力したもののうちの何番目のものであるかを判別する。これにより、入力されたクランク角センサ２４からのパルス出力が何番目の気筒に対応するものであるかを識別され、好ましくは、主に膨張行程（出力行程；ＢＴＤＣ７５°）を現時点で実行中の気筒が識別気筒として識別される。

【００３８】そして、ＥＣＵ２１は、クランク角センサ２４からのパルス信号に応じて、識別気筒グループｍ（ｍは１，２または３）に対応するクランク軸回転角度領域への突入を判別すると、周期計測用タイマ（図示せず）をスタートさせる。次いで、クランク角センサ２４から次のパルス出力を入力すると、ＥＣＵ２１は、識別気筒グループｍに対応するクランク軸回転角度領域からの離脱を判別し、周期計測用タイマの計時動作を停止させて計時結果を読み取る。この計時結果は、識別気筒グループｍに対応するクランク軸回転角度領域への突入時点から当該領域からの離脱時点までの時間間隔ＴＮ（ｎ）、即ち、識別気筒グループに対応する２つの所定クランク軸によって定まる周期ＴＮ（ｎ）を表している。

【００３９】ここで、周期ＴＮ（ｎ）における添字ｎは、当該周期が識別気筒におけるｎ回目（今回）の点火動作に対応することを表す。また、周期ＴＮ（ｎ）は、６気筒エンジンでは識別気筒グループの１２０度クランク角間周期（隣合う気筒における運転状態ＢＴＤＣ７５°相互の時間間隔）になり、より一般的には、Ｎ気筒エンジンでの（７２０°／Ｎ）度クランク角間周期になる。なお、今回の識別気筒に対応するクランク軸回転角度領域からの離脱を表す上記パルス出力は、次の識別気筒に対応するクランク軸回転角度領域への突入をも表す。従って、このパルス出力に応じて、次の識別気筒についての気筒識別ステップが実行されるとともに、当該次の識別気筒に係る周期計測を開始すべく、首記計測用タイマがリスタートされる。

【００４０】このような動作により、ＥＣＵ２１は１２０度クランク間周期ＴＮ（ｎ）を検するが、＃１気筒から＃６気筒に至る一連の状態を表示すると、図７に示すようになり、１２０度クランク間周期は、ＴＮ（ｎ－５）からＴＮ（ｎ）であらわされる。これらの検出値を用いて当該周期におけるクランク軸の角加速度ＡＣＣ（ｎ）を次式により算出する。

ＡＣＣ（ｎ）＝１／ＴＮ（ｎ）・｛ＫＬ（ｍ）／ＴＮ（ｎ）－ＫＬ（ｍ－１）／ＴＮ（ｎ－１）｝

ここで、ＫＬ（ｍ）はセグメント補正値であり、今回の識別気筒に関連して、ベーン製造上及び取付け上のベーン角度間隔のバラツキによる周期測定誤差を除去するための補正を行うべく、ＥＣＵ２１により次式でセグメント補正値ＫＬ（ｍ）が算出される。

【００４１】ＫＬ（ｍ）＝｛ＫＬ（ｍ－３）×（１－ＸＭＦＤＫＦＧ）＋ＫＲ（ｎ）×（ＸＭＦＤＫＦＤ）｝

ただし、ＸＭＦＤＫＦＧはセグメント補正ゲインを示している。またＫＬ（ｍ）におけるｍに対応する気筒グループ毎に設定されるもので、気筒グループ＃１，＃４に対しｍ＝１、気筒グループ＃２，＃５に対しｍ＝２、気筒グループ＃３，＃６に対しｍ＝３がそれぞれ対応し、図７に示すようにＫＬ（１）～ＫＬ（３）が繰り返される。そして、ＫＬ（ｍ－１）におけるｍ－１は、対応するｍの直前のものを意味しているため、ＫＬ（ｍ）＝ＫＬ（１）のときＫＬ（ｍ－１）＝ＫＬ（３）、ＫＬ（ｍ）＝ＫＬ（２）のときＫＬ（ｍ－１）＝ＫＬ（１）、ＫＬ（ｍ）＝ＫＬ（３）のときＫＬ（ｍ－１）＝ＫＬ（２）を示している。

【００４２】更に、上式におけるＫＬ（ｍ－３）は同一気筒グループにおける前の回のＫＬ（ｍ）を示しており、＃４気筒の演算時におけるＫＬ（ｍ－３）は前の＃１気筒におけるＫＬ（１）が用いられ、＃１気筒の演算時におけるＫＬ（ｍ－３）は前の＃４気筒におけるＫＬ（１）が用いられる。＃５気筒の演算時におけるＫＬ（ｍ－３）は前の＃２気筒におけるＫＬ（２）が用いられ、＃２気筒の演算時におけるＫＬ（ｍ－３）は前の＃５気筒におけるるＫＬ（２）が用いられる。＃６気筒の

演算時におけるＫＬ（ｍ－３）は前の＃３気筒におけるＫＬ（３）が用いられ、＃３気筒の演算時におけるＫＬ（ｍ－３）は前の＃６気筒におけるＫＬ（３）が用いられる。一方、上式におけるＫＲ（ｎ）は次式で求められる。

【００４３】ＫＲ（ｎ）＝３・ＴＮ（ｎ）＋ＴＮ（ｎ－１）＋ＴＮ（ｎ－２）

これは、２回前の計測時間ＴＮ（ｎ－２）から今回の計測時間ＴＮ（ｎ）までの平均計測時間に対応した計測値であり、セグメント補正値ＫＬ（ｍ）の算出に際し、ＫＲ（ｎ）に対して、セグメント補正値ゲインＸＭＦＤＫＦＧによる一時フィルタ処理が前述の式を用いて行われる。ところで、本実施例の点火時期制御装置は、角加速度検出手段Ａ６の検出信号を用いて角加速度の変動値を検出する変動検出手段Ａ１を備えている。

【００４４】そして、変動検出手段Ａ１の演算は、検出された各速度を平滑化手段Ａ７により平滑化した平滑値と、角加速度検出手段Ａ６から出力された角加速度との差を求めることにより行われるように構成されている。

【００４５】即ち、変動検出手段Ａ１においては、加速度変動値ΔＡＣＣ（ｎ）が次式により算出される。

ΔＡＣＣ（ｎ）＝ＡＣＣ（ｎ）－ＡＣＣＡＶ（ｎ）

ここでＡＣＣＡＶ（ｎ）は、検出された角速度を平滑化手段Ａ７により平滑化した平滑値であり、次式による一時フィルタ処理を行うことにより算出される。ＡＣＣＡＶ（ｎ）＝α・ＡＣＣＡＶ（ｎ－１）－（１－α）・ＡＣＣ（ｎ）ここでαは一次フィルタ処理における更新ゲインであり、０．９５程度の値が採られる。

【００４６】また、変動検出手段Ａ１から出力される変動値ΔＡＣＣ（ｎ）をエンジンの運転状態に応じて正規化し、正規化変動値ＩＡＣ（ｎ）を求める正規化変動値検出手段Ａ２が設けられる。すなわち、正規化変動値検出手段Ａ２における正規化変動値ＩＡＣ（ｎ）の算出は次式により行われる。

ＩＡＣ（ｎ）＝ΔＡＣＣ（ｎ）・Ｋｔｅ（Ｅｖ，Ｎｅ）

ここで、Ｋｔｅ（Ｅｖ，Ｎｅ）は出力補正係数であり、図１１に示す特性によって設定されるようになっている。

【００４７】図１１の特性は、横軸に体積効率Ｅｖをとり、この体積効率Ｅｖに対する出力補正係数Ｋｔｅ（Ｅｖ，Ｎｅ）を縦軸に採って示されており、エンジン回転数Ｎｅが大きくなるほど右上側の線の特性を採用するように構成されている。従って、図１１の特性がマップとして記憶されており、クランク角センサ２４等の検出信号から算出されるエンジン回転数Ｎｅと体積効率Ｅｖとから、出力補正係数Ｋｔｅ（Ｅｖ，Ｎｅ）がＥＣＵ２１において設定され、エンジン出力に対応した補正による正規化が行われるように構成されている。そして、正規化変動値ＩＡＣ（ｊ）と所定の閾値ＩＡＣＴＨとを比較して、燃焼悪化判定値ＶＡＣ（ｊ）を求める燃焼悪化判定値算出手段Ａ３が設けられており、燃焼悪化判定値ＶＡＣ（ｊ）は、正規化変動値ＩＡＣ（ｊ）が閾値ＩＡＣＴＨを下回る悪化量を累積して求めるように構成されている。

【００４８】即ち、燃焼悪化判定値ＶＡＣ（ｊ）は、次式により算出される。

ＶＡＣ（ｊ）＝Σ｛ＩＡＣ（ｊ）＜ＩＡＣＴＨ｝×｛ＩＡＣＴＨ－ＩＡＣ（ｊ）｝

ここで、上式の｛ＩＡＣ（ｊ）＜ＩＡＣＴＨ｝は、ＩＡＣ（ｊ）＜ＩＡＣＴＨが成立しているとき「１」をとり、成立していないとき「０」をとる関数であり、正規化変動値ＩＡＣ（ｎ）が所定の閾値ＩＡＣＴＨを下回っているとき、この下回った量を悪化量として累積するように構成されている。従って、燃焼悪化判定値ＶＡＣ（ｊ）は、閾値ＩＡＣＴＨと正規化変動値ＩＡＣ（ｊ）との差を重みとした悪化量を累積して求められ、閾値付近の影響を小さくして、悪化の状態を正確に反映しうるように構成されている。

【００４９】そして、燃焼悪化判定値算出手段Ａ３における所定の閾値ＩＡＣＴＨは、閾位置更新手段Ａ８によってエンジン運転状態に対応して更新される。尚、上述の添字ｊは気筒番号を示している。また、燃焼悪化判定値ＶＡＣ（ｊ）としては、より簡単なプログラムを用いて、正規化変動値ＩＡＣ（ｊ）が閾値ＩＡＣＴＨを下まわる回数を累積して求めても良い。即ち、次式によって燃焼悪化判定値ＶＡＣ（ｊ）を求めても良い。

ＶＡＣ（ｊ）＝Σ｛ＩＡＣ（ｊ）＜ＩＡＣＴＨ｝｝

上述のような燃焼悪化判定値算出手段Ａ３からの演算結果は、燃焼状態制御手段Ａ４で用いられるように構成されている。

【００５０】即ち、燃焼状態制御手段Ａ４は、燃焼悪化判定値算出手段Ａ３により算出された燃焼悪化判定値ＶＡＣ（ｊ）及び燃焼悪化気筒ｊを参照し、基準値設定手段Ａ９からのエンジン運転状態に応じて設定される基準点火時期θ_Bについてエンジンの燃焼変動調整要素Ａ５としての点火プラグ３１を制御するように構成されている。燃焼状態制御手段Ａ４による燃焼変動調整要素Ａ５の制御についての基準値として、基準値設定手段Ａ９により上限基準値ＶＡＣＴＨ１と下限基準値ＶＡＣＴＨ２とが設定される。そして、燃焼変動調整要素Ａ５による制御は燃焼悪化判定値をＶＡＣ（ｊ）を上限基準値ＶＡＣＴＨ１と下限基準値ＶＡＣＴＨ２との間に納めるべく行われるように構成されている。

【００５１】即ち、燃焼変動調整要素Ａ５としての点火プラグ３１による制御は、前述のように、点火時期制御に際しての基準点火時期θ_Bの補正により行われるように構成され、制御点火時期θａｄｖは次式で算出されるように構成されている。

$\theta adv = \theta_B + \theta_C + \theta_{I(j)}$

そして、この式における$\theta_{I(j)}$は次のように調整される

ように成っている。まず燃焼悪化判定値ＶＡＣ（ｊ）が上限基準値ＶＡＣＴＨ１を越えている場合には、所定以上に燃焼変動値が悪化している場合であるとして、点火時期を進角させる補正が次式による補正係数$\theta_{I(j)}$の算出により行われるようになっている。

【００５２】$\theta_{I(j)}=\theta_{I(j)}$＋Ｋａｄｖ・｛ＶＡＣ（ｊ）－ＶＡＣＴＨ１｝

これは図８に示す補正特性のうち進角側右上特性の補正値を示し、Ｋａｄｖは特性の傾きを示す係数である。そして、右辺の$\theta_{I(j)}$は、番号ｊ気筒について、前の演算サイクル（ｎ－１）において算出された補正係数を示しており、上式により更新が行われる。なお、図８は横軸に燃焼悪化判定値ＶＡＣをとり、縦軸に補正係数$\theta_{I(j)}$をとって補正特性を示している。一方、燃焼悪化判定値ＶＡＣ（ｊ）が下限基準値ＶＡＣＴＨ２を下回っている場合には、遅角化を行う余裕があるとして、点火時期を遅角させる補正が次式による補正係数$\theta_{I(j)}$の算出により行われるようになっている。

【００５３】$\theta_{I(j)}=\theta_{I(j)}$＋Ｋｒｅｔ・｛ＶＡＣ（ｊ）－ＶＡＣＴＨ２｝

これは図８に示す補正特性のうち遅角側左下特性の補正値を示し、Ｋｒｅｔは特性の傾きを示す係数である。更に、燃焼悪化判定値ＶＡＣ（ｊ）が、下限基準値ＶＡＣＴＨ２以上で、上限基準値ＶＡＣＴＨ１以下である場合には、適正な運転状態であるとして、点火時期を前の状態に保つため、補正係数$\theta_{I(j)}$の変更を行わないように成っている。これは、図８に示す進角側右上特性と遅角側左下特性との間の平坦な特性に対応するもので、補正に関しての不感帯を構成している。

【００５４】ここで、上限基準値ＶＡＣＴＨ１と下限基準値ＶＡＣＴＨ２とは、燃焼変動目標値ＶＡＣ０を中心とし、下限基準値ＶＡＣＴＨ２を（ＶＡＣ０－ΔＶＡＣ）の値に、上限基準値ＶＡＣＴＨ１を（ＶＡＣ０－ΔＶＡＣ）の値に設定されている。燃焼変動目標値ＶＡＣ０は、ＣＯＶ（Coefficient of variance）の目標値(10%程度)に対応した値であり、燃焼変動目標値ＶＡＣ０の両側におけるΔＶＡＣの範囲における点火時期補正をしないようにすることにより、回転変動を有限期間（１２８サイクル）で評価したり、閾値以下のもので演算していることに基因した誤差によるリミットサイクルを防止するようにしている。

【００５５】そして、上述の補正係数$\theta_{I(j)}$は、上下限値でクリップされるように構成されており、例えば、－１＜$\theta_{I(j)}$＜＋５の範囲内に収まるように設定され、急速な補正を行わず、徐々に補正を行うことにより、ショック等の発生を防止し、安定した確実な制御が行われるように構成されている。つぎに、上述のように構成されている本発明の一実施例としての点火時期制御装置を用いての点火時期制御方法を、ＥＣＵ２１の制御プログラムに沿って説明する。

【００５６】図示しないエンジンキーのオン操作と共にエンジン１０のＥＣＵ２１が作動を開始し、メイン処理での制御に入り、各機能のチェック、初期値セット等の初期機能セットがなされ、続いて、エンジンの各種運転情報を読み取り、その上で図１４、図１５の制御処理に達する。ここでは、ステップｓ１で角加速度検出手段Ａ６により角加速度ＡＣＣ（ｎ）が検出される。ここで、検出に用いられる演算は次式による。

【００５７】ＡＣＣ（ｎ）＝１／ＴＮ（ｎ）・｛ＫＬ（ｍ）／ＴＮ（ｎ）－ＫＬ（ｍ－１）／ＴＮ（ｎ－１）｝

ここで、ＫＬ（ｍ）はセグメント補正値であり、今回の識別気筒に関連して、ベーン製造上及び取付け上のベーン角度間隔のバラツキによる周期測定誤差を除去するための補正を行うべく、ＥＣＵ２１により次式でセグメント補正値ＫＬ（ｍ）が算出される。

【００５８】ＫＬ（ｍ）＝｛ＫＬ（ｍ－３）×（１－ＸＭＦＤＫＦＧ）＋ＫＲ（ｎ）×（ＸＭＦＤＫＦＤ）｝

ただし、ＸＭＦＤＫＦＧはセグメント補正ゲインを示している。一方、上式におけるＫＲ（ｎ）は次式で求められる。

【００５９】ＫＲ（ｎ）＝３・ＴＮ（ｎ）＋ＴＮ（ｎ－１）＋ＴＮ（ｎ－２）

これは、２回前の計測時間ＴＮ（ｎ－２）から今回の計測時間ＴＮ（ｎ）までの平均計測時間に対応した計測値であり、セグメント補正値ＫＬ（ｍ）の算出に際し、ＫＲ（ｎ）に対して、セグメント補正値ゲインＸＭＦＤＫＦＧによる一次フィルタ処理が前述の式を用いて行われる。そしてステップｓ２において、平均加速度ＡＣＣＡＶ（ｎ）が算出される。

【００６０】ここで、ＡＣＣＡＶ（ｎ）は、検出された角速度ＡＣＣ（ｎ）を平滑化手段Ａ７により平滑化した平滑値であり、次式による一次フィルタ処理にを行うことにより算出される。

ＡＣＣＡＶ（ｎ）＝α・ＡＣＣＡＶ（ｎ－１）－（１－α）・ＡＣＣ（ｎ）

ここでαは一時フィルタ処理における更新ゲインであり、０．９５程度の値が採られる。次いで、ステップｓ３において、変動検出手段Ａ１により、加速度変動値ΔＡＣＣ（ｎ）が検出される。

【００６１】即ち、角加速度検出手段Ａ６により検出された角速度ＡＣＣ（ｎ）と、平滑化手段Ａ７により平滑化した平滑値としての平均化加速度ＡＣＣＡＶ（ｎ）との差を求めることにより、加速度変動値ΔＡＣＣ（ｎ）が次式で算出される。

ΔＡＣＣ（ｎ）＝ＡＣＣ（ｎ）－ＡＣＣＡＶ（ｎ）

また、ステップｓ４において、正規化変動値検出手段Ａ２により、変動検出手段Ａ１から出力される変動値ΔＡＣＣ（ｎ）をエンジンの運転状態に応じて正規化した正規化変動値ＩＡＣ（ｎ）が次式により算出される。

【００６２】
ＩＡＣ（ｎ）＝ΔＡＣＣ（ｎ）・Ｋｔｅ（Ｅｖ，Ｎｅ）
ここで、Ｋｔｅ（Ｅｖ，Ｎｅ）は出力補正係数であり、図１１に示す特性によって設定される。図１１の特性は、横軸に体積効率Ｅｖをとり、この体積効率Ｅｖに対する出力補正係数Ｋｔｅ（Ｅｖ，Ｎｅ）を縦軸に採って示されており、エンジン回転数Ｎｅが大きくなるほど右上側の線の特性を採用するように構成されている。即ち、マップとして記憶され図１１の特性において、クランク角センサ２４等の検出信号から算出されるエンジン回転数Ｎｅと体積効率Ｅｖとから、出力補正係数Ｋｔｅ（Ｅｖ，Ｎｅ）がＥＣＵ２１において設定され、エンジン出力に対応した補正による正規化が行われる。

【００６３】ここで、上述のような、エンジン出力に対応する正規化をした場合における制御特性に付いて説明する。即ち、角加速度ω'は次式のように示される。
ω'＝１／Ｉｅ・（Ｔｅ－Ｔｌ）・・・・・・・・・①
ここで、Ｔｅ：エンジントルク、Ｔｌ：負荷トルク、Ｉｅ：慣性モーメントを示す。

【００６４】
一方、ω'＝ωｏ'＋Δω'・・・・・・・・・②
ここで、ωｏ'：平均角加速度を示す。

【００６５】①、②式より、
ωｏ'＋Δω'＝１／Ｉｅ・（Ｔｅ－Ｔｌ）
＝１／Ｉｅ・（Ｔｅｏ－Ｔｌ）＋ΔＴｅ／Ｉｅ
よって、Δω'＝ΔＴｅ／Ｉｅ・・・・・・・・・③
ところで前述したステップｓ１における加速度ＡＣＣ（ｎ）の検出手法では、エンジントルク情報が、負荷外乱の無い場合に比較的良く保存される。そして、③式に示すように、平均角加速度ωｏ'からの変動Δωｏ'「加速度変動値ΔＡＣＣ（ｎ）」を用いると共に、慣性モーメントＩｅを考慮した正規化出力「正規化変動値ＩＡＣ（ｎ）」として制御を行うことにより、燃焼変動の統計的性質を考慮し、燃焼室変動を確実に反映させた制御が行われる。

【００６６】ステップｓ４の動作が行われると、次いで、ステップｓ５～ｓ８の燃焼悪化判定値算出手段Ａ３の動作が実行され、正規化変動値ＩＡＣ（ｊ）と所定の閾値ＩＡＣＴＨとを比較して、次式により悪化判定値ＶＡＣ（ｊ）が算出される。

【００６７】ＶＡＣ（ｊ）＝Σ｛ＩＡＣ（ｊ）＜ＩＡＣＴＨ｝×｛ＩＡＣＴＨ－ＩＡＣ（ｊ）｝
まず、ステップｓ７において、正規化変動値ＩＡＣ（ｎ）と所定の閾値ＩＡＣＴＨとの差ΔＩＡＣ（ｎ）が算出され、ついで、ステップｓ８において、差ΔＩＡＣ（ｎ）が負であるかどうかが判断される。この判断は、上式における関数｛ＩＡＣ（ｊ）＜ＩＡＣＴＨ｝に対応するもので、ＩＡＣ（ｊ）＜ＩＡＣＴＨが成立している時「１」をとり、成立していないとき「０」をとる動作を行う。

【００６８】即ち、ＩＡＣ（ｊ）＜ＩＡＣＴＨが成立しているときΔＩＡＣ（ｎ）が正であるため、「Ｎｏ」ルートを通じて、ステップｓ８における燃焼悪化判定値ＶＡＣ（ｊ）の累積が行われ、上記の関数が「１」を採った状態になる。一方、ＩＡＣ（ｊ）＜ＩＡＣＴＨが成立していないときΔＩＡＣ（ｎ）が負であるため、「Ｙｅｓ」ルートを通じて、ステップｓ７によりΔＩＡＣ（ｎ）＝０が実行される。これにより、ステップｓ８では、燃焼悪化判定値ＶＡＣ（ｊ）の累積は行われない状態と成り、上記の関数が「１」を採った状態になる。

【００６９】これにより、図９で点Ａ～Ｄに示すような、正規化変動値ＩＡＣ（ｎ）が所定の閾値ＩＡＣＴＨを下回っているとき、この下回った量を悪化量として累積されることになる。

【００７０】従って、燃焼悪化判定値ＶＡＣ（ｊ）は、閾値ＩＡＣＴＨと正規化変動値ＩＡＣ（ｎ）との差を重みとした悪化量を累積して求められ、閾値付近の数値の影響を小さくして、悪化の状態が燃焼悪化判定値ＶＡＣ（ｊ）に正確に反映される。そして、燃焼悪化判定値ＶＡＣ（ｊ）における所定の閾値ＩＡＣＴＨは、閾値更新手段Ａ８により、エンジン運転状態に対応して更新されるように構成されている。なお、上述の添字ｊは、気筒番号を示しており、各気筒ｊ毎に燃焼悪化判定値ＶＡＣ（ｊ）が累積される。

【００７１】次いで、ステップｓ９が実行され、サンプリングの回数を示すｎが１２８を越えたかどうかが判断される。即ち、図７に示す積算区間を経過したかどうかが判断され、経過していない場合は、「Ｎｏ」ルートをとって、ステップｓ１１を実行し、回数ｎを「１」増加させて燃料補正を行わないままステップｓ１８が実行される。これにより、１２８サイクルの積算区間内について、点火時期θａｄｖにおける補正係数$\theta_{I(j)}$に関する補正は行われず、もっぱら燃焼悪化判定値ＶＡＣ（ｊ）の累積が行われる。

【００７２】したがって、燃焼悪化判定値ＶＡＣ（ｊ）は設定された燃焼回数、例えば、１２８サイクル毎に更新される用に成っており、比較的長い期間を対象とした燃焼状態の把握による制御を行うことにより、統計的な特性を反映する安定した確実な制御が行われる。そして、積算区間が経過すると、ステップｓ９の「Ｙｅｓ」のルートを通じ、ステップｓ１０～ステップｓ１６が実行される。まず、ステップｓ１０において、回数ｎが「１」にリセットされ、次いで、ステップｓ１２とステップｓ１３とにおいて、燃焼悪化判定値ＶＡＣ（ｊ）を参照して、基準値設定手段Ａ９で設定された所定の基準値との比較が行われる。

【００７３】まず、燃焼悪化判定値ＶＡＣ（ｊ）と上限基準値ＶＡＣＴＨ１との比較が行われ、燃焼悪化判定値ＶＡＣ（ｊ）が上限基準値ＶＡＣＴＨ１を越えている場

合、即ち、図１０に示すように、燃焼変動の悪化量が限界を越えている場合は、ステップｓ１３において、次式による補正係数$\theta_{I(j)}$の算出が行われる。

$\theta_{I(j)} = \theta_{I(j)} + Kadv \cdot \{VAC(j) - VACTH1\}$

これは図８に示す進角側右上特性の補正値を算出するもので、所定以上に燃焼変動値が悪化している場合であるとして、点火時期を進角させる補正が$\theta_{I(j)}$の算出によって行われるようになっている。ここでＫａｄｖは特性の傾きを示す係数であり、右辺の$\theta_{I(j)}$は、番号ｊ気筒について、前の演算サイクル（ｎ－１）において算出された補正係数を示しており、上式により更新が行われる。

【００７４】また、燃焼悪化判定値ＶＡＣ（ｊ）が下限基準値ＶＡＣＴＨ２を下回っている場合には、ステップｓ１４において「Ｙｅｓ」ルートをとり、更に遅角化を行う余裕があるとして、点火時期を遅角させる補正が補正係数$\theta_{I(j)}$の算出により行われる。

$\theta_{I(j)} = \theta_{I(j)} + Kret \cdot \{VAC(j) - VACTH2\}$

これは図８に示す遅角側左下特性の補正値を算出するもので、Ｋｒｅｔは特性の傾きを示す係数である。更に、燃焼悪化判定値ＶＡＣ（ｊ）が、下限基準値ＶＡＣＴＨ２以上で、上限基準値ＶＡＣＴＨ１以下である場合には、ステップ１２及びステップｓ１３においていずれも「Ｎｏ」ルートをとり、適正な運転状態であるとして、点火時期を前の状態に保つため、補正係数$\theta_{I(j)}$の変更を行わない。

【００７５】これは、図８に示す進角側右上特性と遅角側左下特性との間の平坦な特性に対応するもので、補正に関しての不感帯を構成している。ここで、上限基準値ＶＡＣＴＨ１と下限基準値ＶＡＣＴＨ２とは、点火時期変動目標値ＶＡＣ０を中心とし、下限基準値ＶＡＣＴＨ２を（ＶＡＣ０－ΔＶＡＣ）の値に、上限基準値ＶＡＣＴＨ１を（ＶＡＣ０－ΔＶＡＣ）の値に設定されている。燃焼変動目標値ＶＡＣ０は、ＣＯＶ（Coefficient of variance）の目標値(10%程度)に対応した値であり、燃焼変動目標値ＶＡＣ０の両側におけるΔＶＡＣの範囲における点火時期補正をしないようにすることにより、回転変動を有限期間（１２８サイクル）で評価したり、閾値以下のもので演算していることに基因した誤差によるリミットサイクルを防止するようにしている。

【００７６】そして、ステップｓ１６が実行され、燃焼悪化判定値ＶＡＣ（ｊ）が「０」にリセットされる。更に、ステップｓ１７において、補正係数$\theta_{I(j)}$が、上下限値を越えた場合には、越えた側の限界値にクリップされる。例えば、$-1 < \theta_{I(j)} < +5$の範囲内に収まるように設定された場合、ステップｓ１３における算出値が＋５を越えると＋５に設定され、ステップｓ１４における算出値が－１を下回ると－１に設定される。これにより、急速な補正を行わず、徐々に補正を行うことにより、ショック等の発生を防止し、安定した確実な制御が行われる。

【００７７】そしてステップｓ１８において、上述のようにして決定された補正係数$\theta_{I(j)}$による点火処理に際しての基本点火時期θ_Bの補正が行われる。即ち制御点火時期θａｄｖは次式で算出される。

$\theta adv = \theta_B + \theta_C + \theta_{I(j)}$

この基本点火時期θ_Bの補正により、燃焼状態制御手段Ａ４による燃焼変動調整要素である点火プラグ３１の点火制御が行われる。この点火制御は各気筒（ｊ）毎に実行され、図１２に示すように、各気筒毎に遅角処理あるいは進角処理が実行され、全気筒の出力レベルが同レベルに揃えられる。このため、エンジン１０は安定した運転状態に保たれ、各気筒間の出力のバラツキによる車体側への振動の励起が防止される。

【００７８】

【発明の効果】請求項１の発明は、内燃機関の回転角加速度の変動値が各気筒毎に求められ、この変動値または判定値のいずれか一方が内燃機関の運転状態に応じて正規化され、両者が比較されて各気筒の出力に関連する燃焼状態が判定され、出力の異なる燃焼状態を示す気筒の出力がその他の気筒の出力に近づくように、出力の異なる燃焼状態を示す気筒の点火時期がその他の気筒の点火時期に対し補正されるので、この補正により出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を応答性良く規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００７９】請求項２の発明は、内燃機関の回転角加速度の変動値が各気筒毎に求められ、この変動値または判定値のいずれか一方が内燃機関の運転状態に応じて正規化され、両者が比較されて各気筒の出力に関連する燃焼状態が判定され、出力の大きな燃焼状態を示す気筒の点火時期が出力の小さな燃焼状態を示すその他の気筒の点火時期より遅角側に補正されるので、この補正により出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を応答性良く規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００８０】請求項３の発明は、内燃機関の回転角加速度の変動値が各気筒毎に求められ、この変動値または判定値のいずれか一方が内燃機関の運転状態に応じて正規化され、両者を比較されて各気筒の出力に関連する燃焼状態が判定され、出力の小さな燃焼状態を示す気筒の点火時期を出力の大きな燃焼状態を示すその他の気筒の点火時期より進角側に補正されるので、この補正により出力の異なる気筒の出力がその他の気筒の出力に近づくよ

うになる。このため、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を応答性良く規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００８１】請求項４の発明は、請求項１乃至請求項３記載の点火時期制御方法において、特に、内燃機関の回転角加速度の変動値は、内燃機関の運転状態がアイドル運転時に求められるので、アイドル時において出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、アイドル時における各気筒間の出力の変動を応答性良く規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００８２】請求項５の発明は、請求項１乃至請求項３記載の点火時期制御方法において、特に、内燃機関の回転角加速度の変動値は、上死点における瞬間回転角速度と下死点における瞬間回転角速度とを用いて求めるので、比較的容易に回転角加速度の変動値を求められる。このため、回転角加速度の変動値を確実に求められ、各気筒間の出力変動に基因する車体振動をより確実に防止出来る。

【００８３】請求項６の発明は、請求項５記載の点火時期制御方法において、特に、内燃機関の回転角加速度の変動値は、上死点における瞬間回転角速度と下死点における瞬間回転角速度とから回転角加速度を求め、この回転角加速度とその平均値との偏差から回転角加速度の変動値を求めるので、比較的容易に回転角加速度の変動値を求められる。このため、回転角加速度の変動値を確実に求められ、車体振動をより確実に防止出来る。

【００８４】請求項７の発明は、請求項６記載の点火時期制御方法において、特に、回転角加速度の今回の平均値は、今回求められた回転角加速度と前回までの平均値との重み付けにより求められ、算出された平均値の信頼性が高まる。このため、算出された回転角加速度の変動値の信頼性が高まり、車体振動をより確実に防止出来る。

【００８５】請求項８，９の発明は、請求項１乃至請求項３記載の点火時期制御方法において、特に、回転角加速度の変動値または判定値のいずれか一方の正規化は、内燃機関のエンジン回転数及び吸気情報、例えば、体積効率に応じて補正するので、この補正を応答性良く行え、出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、応答性良く各気筒間の出力の変動を規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００８６】請求項１０、１１の発明は、請求項１乃至請求項３記載の点火時期制御方法において、特に、正規化を実施した後、回転角加速度変動値と判定値とを比較し、回転角加速度変動値が判定値を上回る回数を求め、その回数が大きいほど点火時期を進角側に補正し、あるいは点火時期の進角、保持、遅角の切換えを行うので、この補正により出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を応答性良く規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００８７】請求項１２の発明は、請求項１１記載の点火時期制御方法において、特に、回数が第１の判定回数以上のとき点火時期を進角し、回数が第１の判定回数より小さい第２の判定回数より小さいとき点火時期を遅角し、回数が第１判定回数より小さく且つ第２の判定回数以上のときに点火時期を保持するという切換えを行ってもよく、この補正により出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を応答性良く規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００８８】請求項１３の発明は、請求項１乃至請求項３記載の点火時期制御方法において、特に、回転角加速度の変動値と判定値とのいずれか他方をエンジンの運転状態に応じて変更するので、この変更によって、出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を応答性良く規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００８９】請求項１４，１５の発明は、請求項１３記載の点火時期制御方法において、特に、回転角加速度の変動値と判定値とのいずれか他方をエンジン回転数と吸気情報、例えば、体積効率に応じて変更するので、この補正を応答性良く行え、出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、応答性良く各気筒間の出力の変動を規制でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【００９０】請求項１６の発明は、変動検出手段によって内燃機関の回転角加速度の変動値が検出され、正規化値検出手段によって変動検出手段で検出された変動値または判定値のいずれか一方が内燃機関の運転状態に応じて正規化されて正規化変動値または正規化判定値が求められ、燃焼悪化判定値算出手段によって正規化変動値または正規化判定値と変動値または判定値とが比較されて燃焼悪化判定値が求められ、点火制御手段によって、燃焼悪化判定値が参照されて、出力の異なる燃焼状態を示す気筒の出力がその他の気筒の出力に近づくように出力の異なる燃焼状態を示す気筒の点火時期がその他の気筒の点火時期に対し補正されるように点火駆動回路が制御されるので、この補正により出力の異なる気筒の出力がその他の気筒の出力に近づくようになる。このため、エンジン構成部品のバラツキや、動弁系のバルブタイミングのずれによる各気筒間の出力の変動を応答性良く規制

でき、各気筒間の出力変動に基因する車体振動を防止出来る。

【図面の簡単な説明】

【図１】本発明の一実施例としての点火時期制御方法を採用し、その装置を装備するエンジンの概略構成図である。

【図２】図１の点火時期制御装置のＥＣＵが備える機能ブロック面である。

【図３】図１の点火時期制御装置のＥＣＵ及び点火制御回路の概略構成図である。

【図４】図１の点火時期制御装置が用いる点火制御回路内の点火駆動部の機能構成図である。

【図５】図４の点火駆動部の作動を示す波形図である。

【図６】図１の点火時期制御装置を備えたエンジンの点火順序の説明図である。

【図７】図１の点火時期制御装置を備えたエンジンの回転作動を説明するための波形図である。

【図８】図１の点火時期制御装置のＥＣＵが用いる補正係数$\theta_{I(j)}$算出マップの特性線図である。

【図９】図１の点火時期制御装置を備えたエンジンの変動加速度の波形図である。

【図１０】図１の点火時期制御装置のＥＣＵが用いる正規化変動値と閾値の差である悪化積算値－燃焼変動値の特性線図である。

【図１１】図１の点火時期制御装置のＥＣＵが正規化で用いる出力補正係数算出マップの特性線図である。

【図１２】図１の点火時期制御装置の各気筒の点火時期の補正を説明する図である。

【図１３】図１の点火時期制御装置が用いる回転変動検出部を示す模式的斜視図である。

【図１４】図１の点火時期制御装置のＥＣＵが行う制御プログラムのフローチャートの上部である。

【図１５】図１の点火時期制御装置のＥＣＵが行う制御プログラムのフローチャートの下部である。

【図１６】従来の点火時期制御装置を備えたエンジンの第１、第２バンクにおけるタイミングベルトの変動の説明図である。

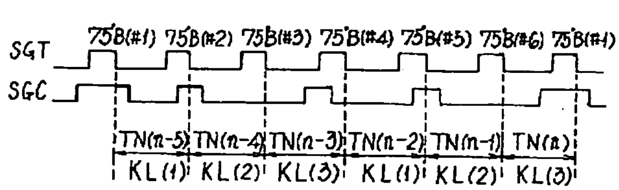
【図１７】従来の点火時期制御装置を備えたエンジンの各気筒毎の出力特性図である。

【図１８】従来の点火時期制御装置を備えたエンジンの各気筒毎のオーバーラップ量、吸入空気量の特性図である。

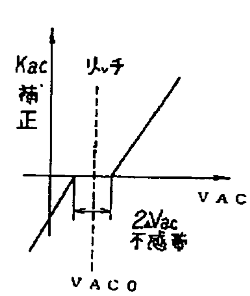
【符号の説明】

１０	エンジン
１４	エアフローセンサ
２０	スロットルセンサ
２１	ＥＣＵ
２４	クランク角センサ
２７	ＴＤＣセンサ
２９	ノックセンサ
３１	点火プラグ
３４１～３４６	点火駆動部
３５	クランク軸
θａｄｖ	点火時期
Ａ６	角加速度検出手段
ＴＮ（ｎ）	クランク間周期
Ａ１	変動検出手段
Ａ２	正規化変動値検出手段
Ａ３	燃焼悪化判定値算出手段
Ａ４	燃焼状態制御手段
Ａ５	燃焼変動要素
Ａ６	角加速度検出手段
Ａ７	平滑化手段
Ａ８	閾値更新手段
Ａ９	基準値設定手段
θ_B	基本点火時期
Ｅｖ	体積効率
Ｎｅ	エンジン回転数
Ａ／Ｎ	エンジン１回転当たりの吸入空気量
$\theta_{I(j)}$	燃焼変動補正値
ω’	角加速度
ωｏ’	平均角加速度
$\Delta\omega$ｏ’	変動
ΔＡＣＣ（ｎ）	加速度変動値
Ｉｅ	慣性モーメント
ＩＡＣ（ｎ）	正規化変動値

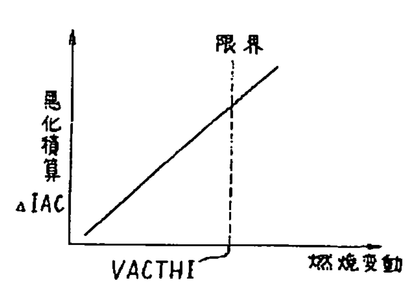
【図７】



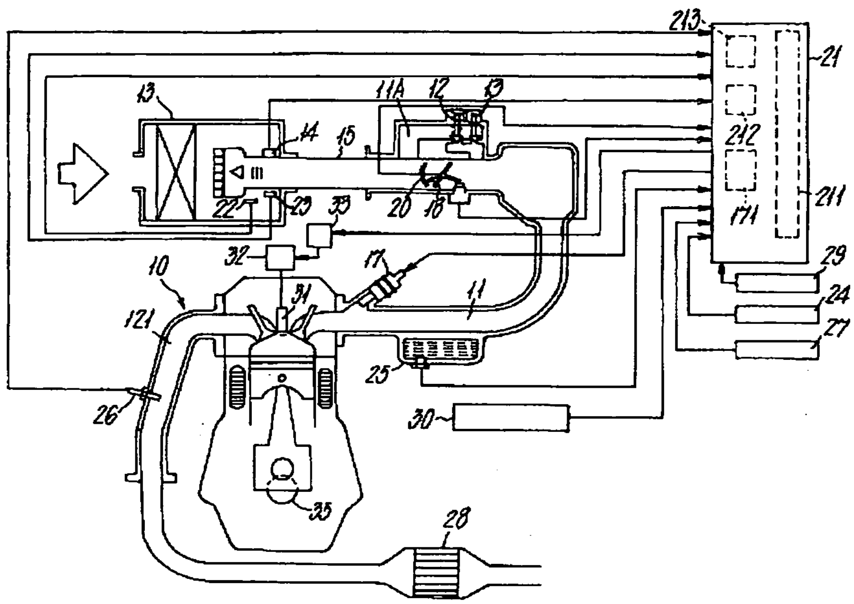
【図８】



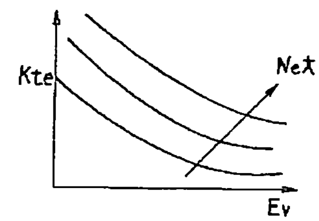
【図１０】



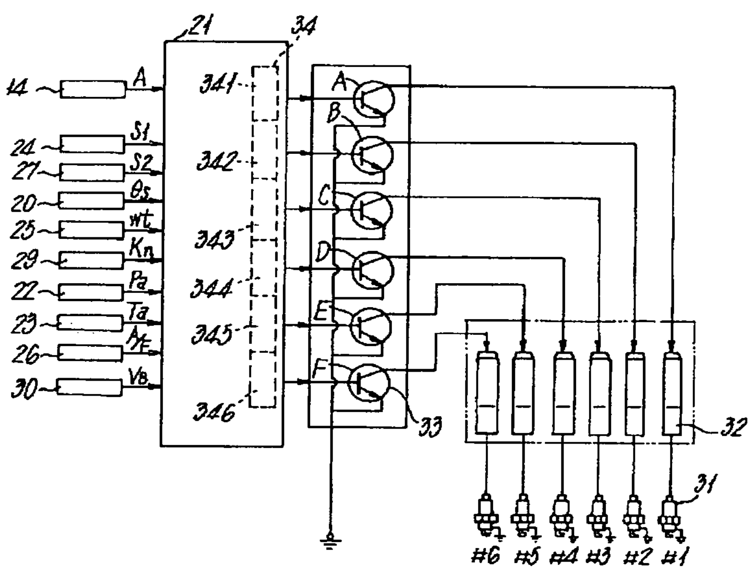
【図１】



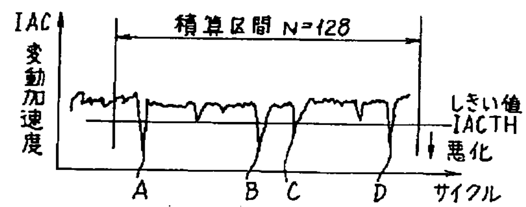
【図１１】



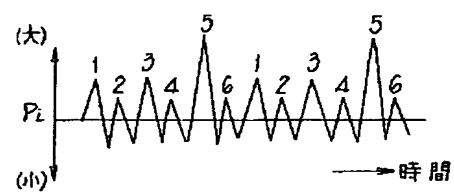
【図３】



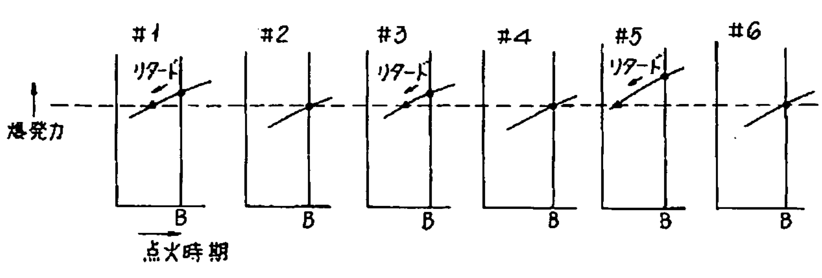
【図９】



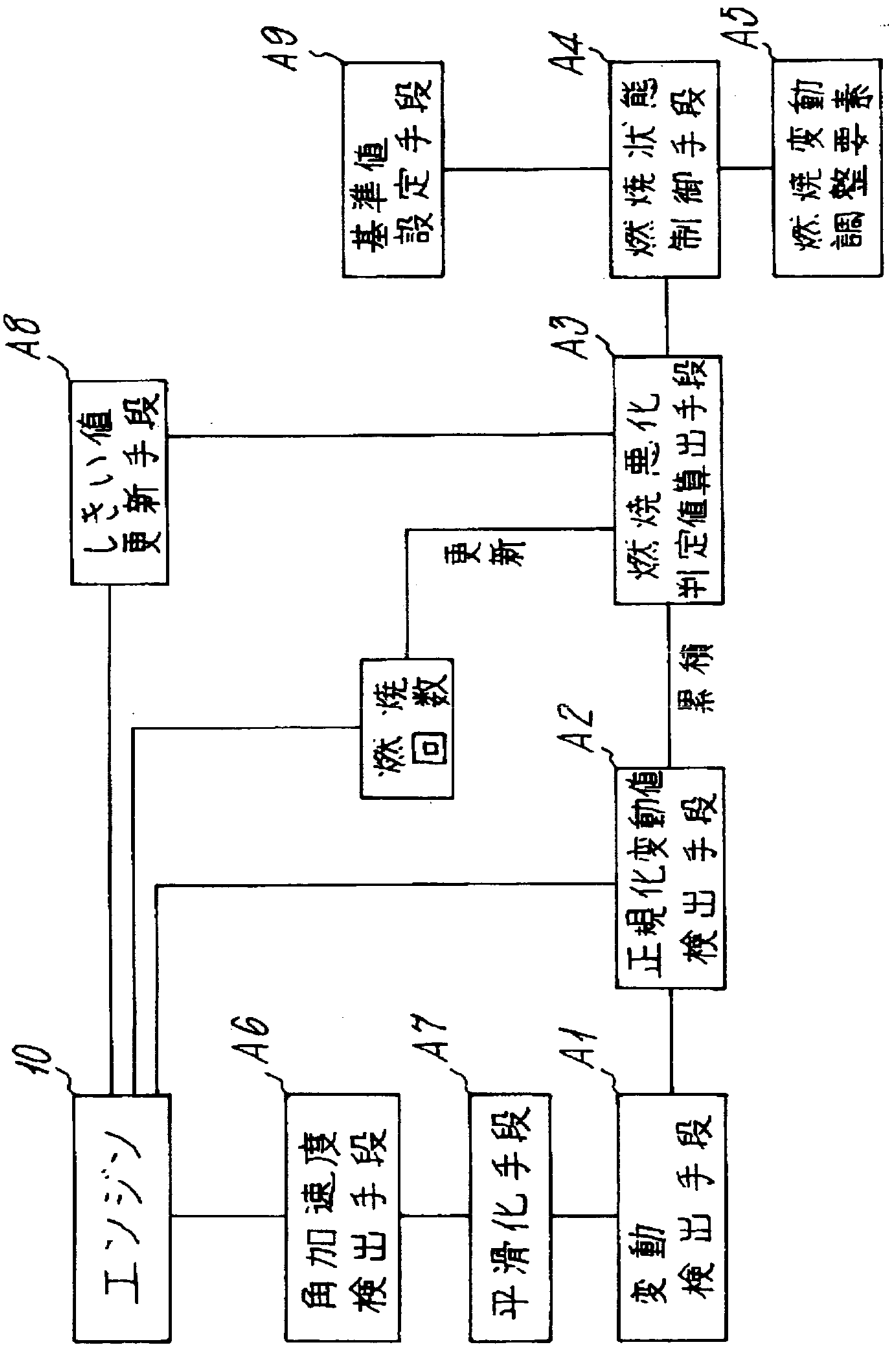
【図１７】



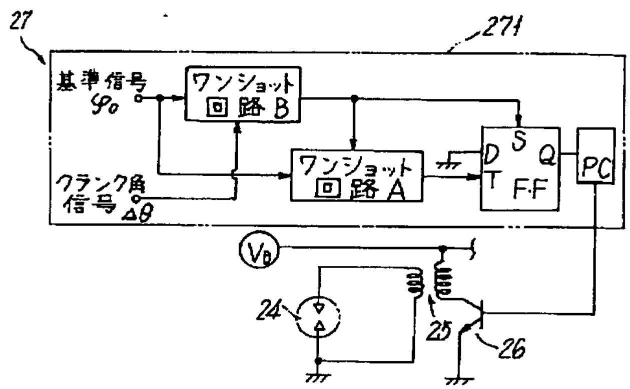
【図１２】



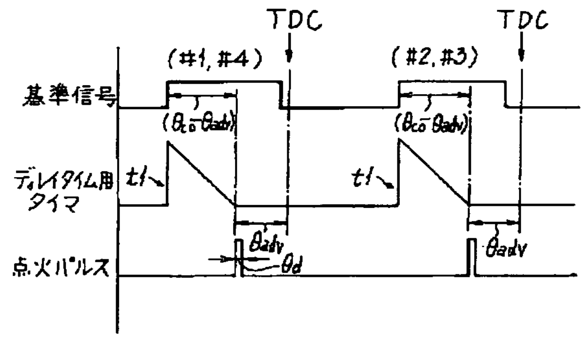
【図２】


10
エンジン
A6
角加速度検出手段
A7
平滑化手段
A1
変動検出手段
A2
正規化変動値検出手段
累積
燃焼回数
更新
A3
燃焼悪化判定値算出手段
A8
しきい値更新手段
A4
燃焼状態制御手段
A9
基準値設定手段
A5
燃焼変動要素調整手段

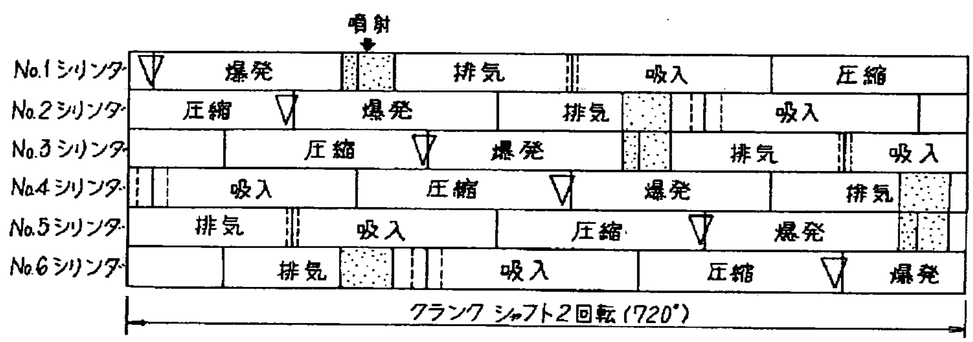
【図４】



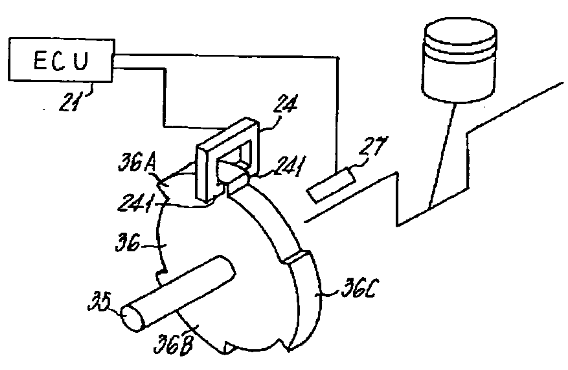
【図５】



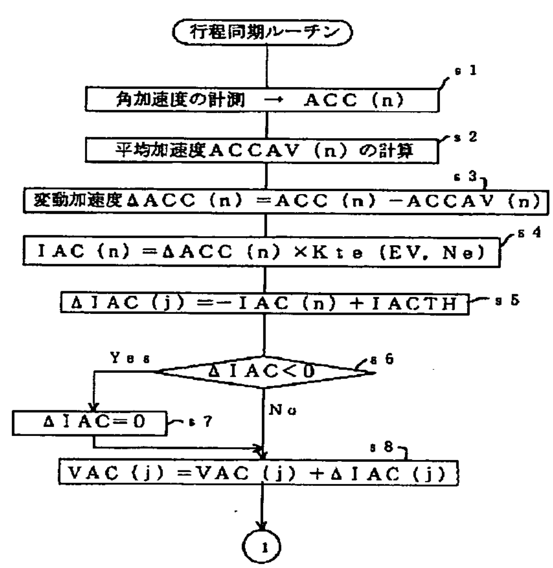
【図６】



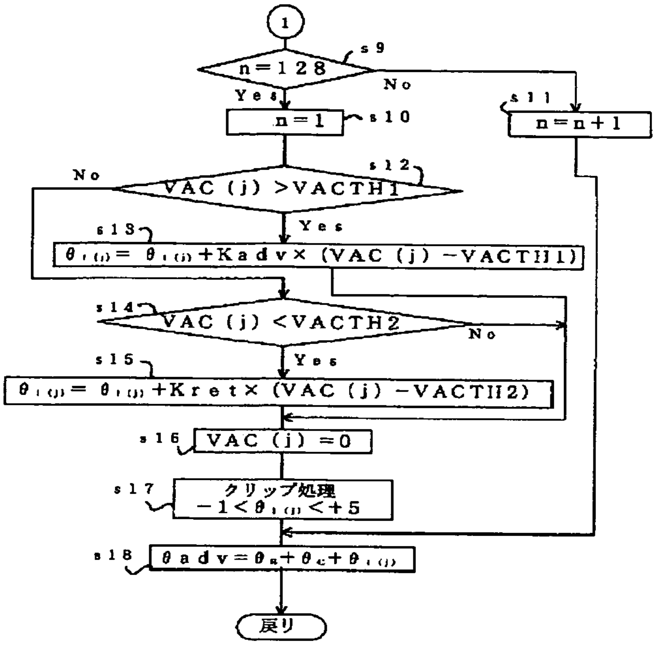
【図１３】



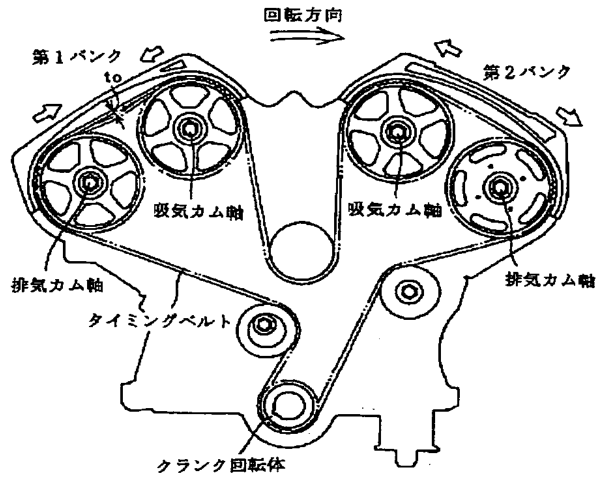
【図１４】



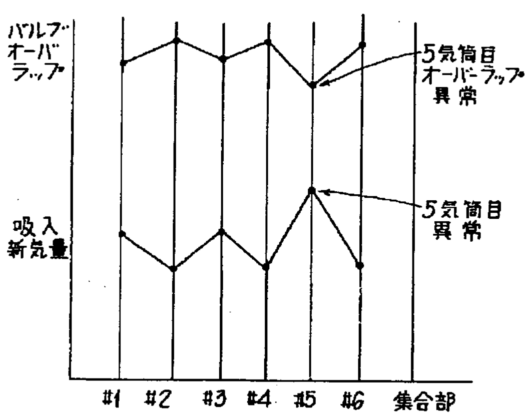
【図15】


1
s9
n=128
Yes
No
s10
n=1
s11
n=n+1
s12
No
VAC (j) >VACTH1
Yes
s13
θ₁₍ⱼ₎= θ₁₍ⱼ₎+Kadv× (VAC (j) −VACTH1)
s14
VAC (j) <VACTH2
No
Yes
s15
θ₁₍ⱼ₎= θ₁₍ⱼ₎+Kret× (VAC (j) −VACTH2)
s16
VAC (j) =0
s17
クリップ処理
−1<θ₁₍ⱼ₎<+5
s18
θadv=θ₈+θc+θ₁₍ⱼ₎
戻り

【図16】


回転方向
第1バンク
to
第2バンク
吸気カム軸
吸気カム軸
排気カム軸
排気カム軸
タイミングベルト
クランク回転体

【図18】


バルブオーバラップ
5気筒目オーバーラップ異常
吸入新気量
5気筒目異常
#1
#2
#3
#4
#5
#6
集合部